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BIOPSY OF THE RECTUM

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HISTORICAL INTRODUCTION

BY the time that some surgical procedures have become current practice it often proves difficult to discover when and by whom they were originated. This is the case with biopsy of the rectum. A forecast of its possibility was given by Cooper and Edwards (1892) when they said, under the heading "Diagnosis of Rectal Cancer": "When induration or a tumour can be detected by the finger, its position and extent should be very carefully investigated. . . . It sometimes happens that a fragment can be detached by the finger, and a microscopical examination will then aid in determining the nature of the case."

It seems appropriate that of all the authorities whom we have consulted, the earliest and one of the most complete reports so far discovered is by that great surgeon, James P. Tuttle (1903), the author of a famous treatise on the rectum. In this, discussing the symptoms of carcinoma of the rectum, he says: "It is not sufficient to introduce the finger 3 or 4 inches into the rectum and, if no neoplasm or pathological condition is observed, exonerate the rectum and the sigmoid from any part in the production of these symptoms. A more careful and extensive examination is necessary. By the pneumatic proctoscope and specimen forceps it is possible to bring into view and take sections from every portion of the sigmoid flexure and determine almost in the earliest stages of this disease its existence and its site." Later on he adds: "It is important in obtaining specimens for microscopic examination not to crush them. This can be done by use of nasal scissors or the specimen forceps. The bite of the latter consists in two elliptical Volkmann spoons, which cut out the specimen and hold it in the cavity formed by their approximation; the instrument is 12 inches long, and was devised for operation through the sigmoidoscope. By it specimens may be obtained from any part of the pelvic colon." (*Fig.* 558.)

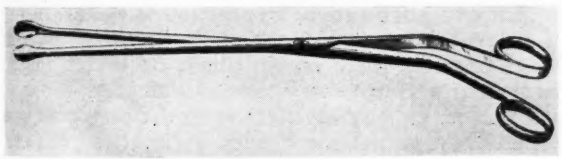

FIG. 558.—Rectal specimen forceps (Tuttle).

The next report we find is by Goodsall and Miles (1905), who give the following opinion on the differential diagnosis of carcinoma of the rectum: "Hence it is of the utmost importance that no doubt as to the exact nature of the disease should exist, and that other non-carcinomatous affections should not be mistaken for it. In all cases in which the slightest element of doubt exists a small piece of the growth should be removed for microscopical examination, the question of an operation being deferred until the histological characters of the neoplasm have been ascertained."

Bensaude and Cain (1921) published a detailed paper on the indications, technique, and interpretation of biopsy in tumours of the rectum. They recommended that biopsy should, as a general rule, be reserved for difficult cases and for those which appeared to be atypical. The microscopical features, as revealed by biopsy, of the chief rectal tumours, such as adenoma, villous tumour, and adenocarcinoma, were clearly depicted. Parts of this paper are more readily accessible in Bensaude's well-known and beautifully illustrated work—*Traité d'Endoscopie* (1926), in which we see Brünings' forceps illustrated and recommended for biopsy on the score of its neatness, lightness, suppleness, and, above all, for the effectiveness of its jaws.

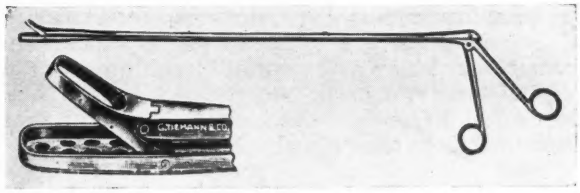

FIG. 559.—Yeomans' biopsy forceps.

Yeomans (1921) gave a modern and clear account of biopsy of the rectum and illustrated his long biopsy forceps (*Fig.* 559); this instrument was 13 in. long, which permitted its use through a 10-in. sigmoidoscope; the upper mobile jaw had a cutting edge and the specimen rested intact on the grilled floor, which measured 1 × 2 cm. Yeomans stated that he had used this instrument in a large number of cases with gratifying results and no unfavourable consequences. In addition, he stated that: "In a few instances, after operation, the question has arisen of diagnosing malignant recurrence from stenosing

scar tissue at the line of intestinal suture. Biopsy determined this point promptly and decisively."

Rankin (1929) was impressed by the importance of Broders' index of malignancy, and in order to detect the tumours of a high grade of malignancy when radium treatment might sometimes be preferred to radical operation, he advised examination of biopsy fragments; the fragments were removed by means of a diathermy knife and were graded before deciding on treatment.

In this country, one of us (Gabriel, 1931), following a visit to Dr. R. Bensaude's rectal clinic at

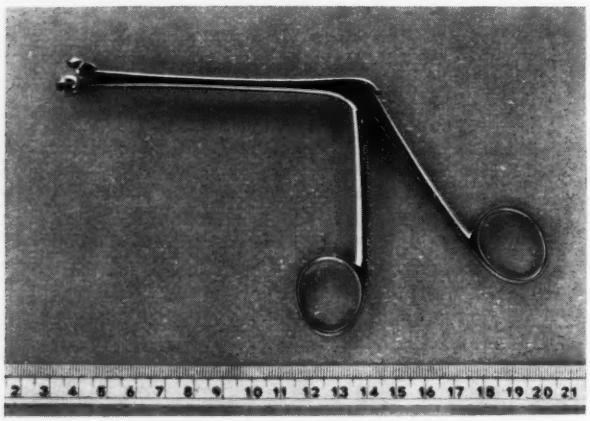

FIG. 560.—Hartmann's conchotome (the 'small-medium' size is recommended—from Messrs. Down Bros. and Mayer & Phelps).

l'Hôpital St. Antoine, Paris, described the usefulness of Brünings' forceps for purposes of biopsy and recommended this as a routine procedure prior to surgical treatment being undertaken. In this paper the clinical diagnosis of carcinoma of the rectum was confirmed in 40 cases examined.

Buie (1932) referred to the importance of biopsy of malignant tumours as a routine measure; he considered that the information given by histological grading of biopsy fragments could give valuable assistance to the surgeon. For instance, in an otherwise operable tumour an excessively cellular structure as revealed by biopsy might sometimes cause it to be judged as inoperable, and conversely a borderline growth with some local fixity might be considered operable if biopsy showed it to be of a low histological grade. He thought that biopsy did not carry any risk of disseminating the disease provided that only a small specimen was taken and the area from which it had been taken immediately cauterized; a curative operation should be performed without delay. Buie also recorded the opinion that "a positive report after microscopic examination is conclusive, but a negative report is not", and with this, of course, we are all in agreement.

During the last twenty years biopsy has been a routine pre-operative procedure at St. Mark's Hospital, not only for confirmation of the diagnosis in all types of rectal neoplasms but for the elucidation of the diagnosis in obscure and anomalous lesions, and during this period well over 4000 biopsy sections have been examined in the pathology department. In more than half of these cases the biopsy was followed by surgical removal of the tumour or other lesion, thus giving an opportunity for checking the biopsy diagnosis. This long experience has convinced us of the general reliability and usefulness of biopsy in rectal and anal lesions.

TECHNIQUE OF BIOPSY

The aim should be to remove large fragments, if possible 5 to 8 mm. in diameter. They are taken from the most readily accessible part of a protuberant growth or the raised margin of an ulcer.

In the case of a villous tumour with suspected malignant change the biopsy fragments should be taken from several areas, particularly those which can be felt to be indurated or appear to be friable.

Special preparation, for example by enemas, is needed only when the lesion to be investigated by biopsy proves to be persistently obscured by blood, mucus, or fluid fæces coming down from above. It is certainly correct to state that biopsy of a suspected rectal carcinoma is a procedure which can, in the great majority of cases, be carried out routinely at the patient's first hospital attendance.

Biopsy through a Proctoscope.—For biopsy of a low-lying rectal growth, i.e., in or below the rectal ampulla, there is, we think, no better instrument than a Hartmann's conchotome (*Fig.* 560). It has proved equally as effective in the easy case with a well-defined malignant edge as in those difficult cases in which a stricture with densely hard walls or a scirrhous excavated ulcer present for examination. The fragments removed by a conchotome come off cleanly and uncrushed, and provide a large, excellent picture of the histology.

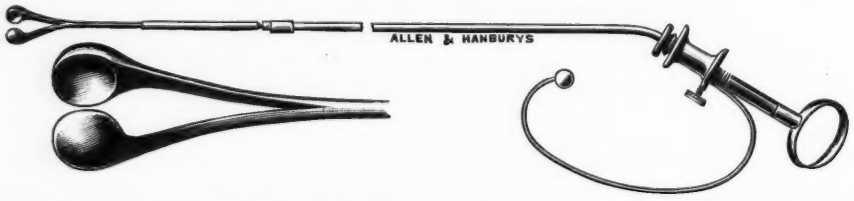

FIG. 561.—Brünings' forceps. The inset shows the hollowed cutting ends, 8 mm. in diameter, in natural size.

Anæsthesia, for instance with intravenous pentothal, may be necessary when a malignant ulcer, whether squamous or columnar-celled, involves the anal canal or invades the sphincter musculature and in consequence is extremely painful. An injection of pentothal as a relaxant sometimes proves very helpful in doing a biopsy of a lesion in the lower rectal third *posteriorly* when a tight contraction of the puborectalis sling renders access by a proctoscope difficult.

Biopsy through a Sigmoidoscope.—For biopsy of a lesion above the reach of a proctoscope

a longer instrument is necessary and four patterns of long biopsy forceps are illustrated. The oldest of these, and the one which has become endeared to us by long usage, is Brünings' forceps (*Fig.* 561); it should be fitted with cups 8 mm. in diameter and much care is needed to keep this instrument in perfect working order, particularly by way of restraining the Nursing Staff from thrusting it into the sterilizer, and by careful cleaning, together with the regular use of 3-in-1 oil on the working parts.

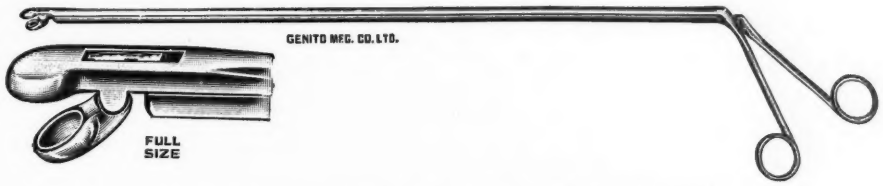

FIG. 562.—Long biopsy forceps (Genito-Urinary Co. Ltd.).

The other biopsy forceps illustrated (*Fig.* 562) has given good and faithful service for many years; there is no greater test for an instrument than when it is used in a busy out-patient department for six sessions a week, month after month, and is handled by many different people.

The long biopsy forceps just mentioned have straight cutting jaws; others are available with angulated jaws, such as that illustrated in *Fig.* 563. This instrument has very strong cutting jaws and is particularly useful in the very scirrhous type of lesion in which it is difficult to get a good bite with the straight biopsy forceps. Another instrument with angulated jaws is that described by Turrell (1942); this has a rotating mechanism with a locking device near the handle which permits the shaft to be turned until the cutting jaws directly face the lesion to be examined (*Fig.* 564).

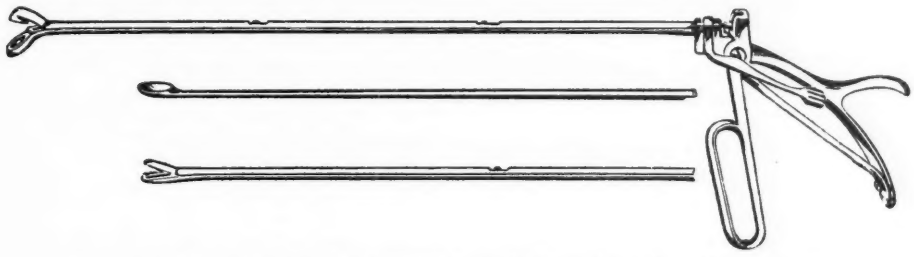

FIG. 563.—Biopsy forceps 16 in. long, with angulated cutting ends. (Vann Bros. Ltd.)

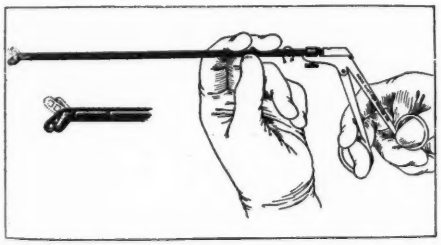

FIG. 564.—Turrell's angulated biopsy forceps, indicating the rotary movement of the shaft. (Reproduced from the *Annals of Surgery*, 1942, **116**, 637.)

An 'average catch' with biopsy forceps is illustrated in *Fig.* 565.

COMPLICATIONS

Dissemination.—We have no evidence whatsoever to suggest that biopsy introduces a risk of dissemination of a rectal carcinoma either by the lymphatic pathways or by the blood-stream. The trauma involved by biopsy is superficial and minimal, and quite different from biopsy of a tumour when performed by cutting through healthy tissues.

The question of biopsy of an anomalous lesion at the anal margin is a distinct problem and each case must be decided on its clinical merits. For instance, if it is a question of deciding between a columnar-celled or squamous-celled carcinoma or between a simple ulcer, a tuberculous ulcer, or a squamous carcinoma, a biopsy is usually both necessary and important: whereas no one would willingly contemplate doing a biopsy of a suspicious anal chancre, when the diagnosis can readily be made by other routine methods! A biopsy is likely to prove of little help in cases of leucoplakia of the anus or

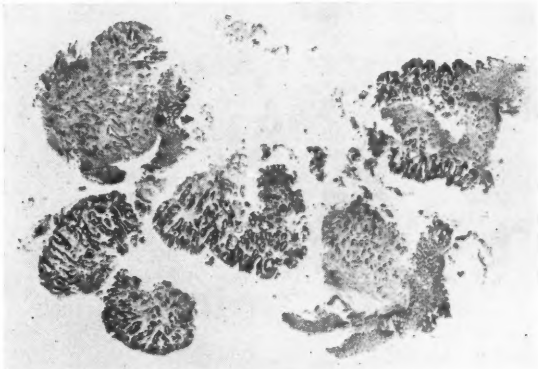

FIG. 565.—Low-power view of 'average catch' with Brünings' forceps. (× 3·3.)

long-standing fistulæ with doubtful malignant change; it is better practice in such cases for the suspected area to be excised with an adequate margin of healthy tissue and sent for microscopical examination.

The greatest possible care should be exercised in dealing with a suspected malignant melanoma of the anal canal or anus, and if a biopsy is considered essential it should be delayed until the patient has been admitted to hospital, when a radical operation can be performed without delay as soon as the pathologist has given his report.

Hæmorrhage.—Rectal neoplasms vary a good deal in vascularity and, as might be expected, the rather infrequent cases of sarcoma of the rectum tend to be more vascular than the ordinary adenocarcinoma. The slight amount of hæmorrhage which not infrequently occurs immediately after a biopsy has been done is quickly controlled by firm pressure with cotton-wool swabs, either dry or moistened with 1–1000 adrenaline; these swabs can conveniently be held in the same forceps that has been used for the biopsy, and the proctoscope or sigmoidoscope should not be removed until the field is seen to be dry.

More severe hæmorrhage of a degree that causes anxiety either from difficulty in controlling it or from its general effect on the patient is extremely rare and the following details refer to the only case of this type which has come to our notice :—

Case.—Mrs. M. J. T., aged 49, was admitted into St. Mark's Hospital with a deeply ulcerated carcinoma in the lower third of the rectum; it was about 2 in. in diameter and was invading the anal canal. A biopsy was done and was later reported to show an adenocarcinoma of average grade. On the day following the biopsy some blood was noted when an enema was given, and at 10 p.m. she passed more than a pint of blood and fainted. Her pulse-rate at this time was 70, with a systolic blood-pressure of 80 mm. Hg. The rectum was irrigated with warm hazeline solution and then packed with a tube and gauze surround by Lockhart-Mummery's method. A blood transfusion was given and was followed by a satisfactory improvement; no further bleeding took place and next day her blood-pressure was restored to 150/90. A radical excision of the rectum was successfully carried out in due course.

Perforation.—Although a biopsy has been done on many hundreds of cases for tumours above the peritoneal reflection, for submucous tumours, and for tumours invading the rectum from without inwards, such as advanced carcinoma of the pelvic colon and endometrioma, we can only record one clear-cut case of perforation of the rectal wall with a biopsy forceps.

Case.—F. W., a male aged 72, was examined as an out-patient at St. Mark's Hospital in July, 1948, in regard to bleeding and mucous discharge from the rectum. A soft tumour was felt digitally and sigmoidoscopy showed a villous tumour extending 4–10 cm. above the anus. A biopsy was done and the patient returned home, but next day he was admitted into his local general hospital in a very ill state, with a distended abdomen and all the signs of a general peritonitis. Laparotomy proved his abdomen to be full of pus, but the source was not found. His abdomen was drained and he died on the following day. A post-mortem examination was done and revealed a perforation ½ cm. in diameter in the rectal wall; there were two cauliflower-like growths in the rectum, both about 2½ cm. in diameter, flat, sessile, and confined to the mucosal coat. The perforation had taken place just to one side of the upper growth. No metastases were found in the glands or elsewhere. The biopsy was reported to show a typical villous papilloma.

In addition there is one other case in which it seemed possible that a pelvic abscess and peritonitis might have been precipitated, or possibly originated, by the biopsy, although there is no definite proof :—

Case.—The patient, T. T., was a pale frail old man of 72, who was examined in the out-patient department at St. Mark's Hospital, and was found to have a fixed infiltrating rectosigmoid carcinoma which could be felt digitally high up anteriorly. A typical carcinoma was seen at 15 cm. and a biopsy was done by one of us (W. B. G.). His abdomen was slightly distended, and palpable fæcal masses were felt in the left iliac fossa.

He was admitted ten days later with a more distended and tense abdomen; there was visible peristalsis and the left side of the colon was loaded and palpable. Laparotomy revealed a pelvic peritonitis spreading upwards from a pelvic abscess. The pelvis was occupied by a hard fixed rectosigmoid growth (by now proved by the biopsy to be an adenocarcinoma of average grade). There was a considerable degree of diverticulosis of the iliac and pelvic colon which proved to be very difficult to mobilize owing to the small-gut distension, so the pelvis was drained and the abdomen closed. With the usual supportive treatment, together with penicillin and streptomycin, the patient made a steady recovery and three weeks later a palliative left iliac loop colostomy was successfully effected; the pelvis was not explored again and no further evidence was forthcoming as to the exact cause of the pelvic abscess; in view of the fæcal obstruction already present at the time of the first examination, it seems more reasonable to presuppose a ruptured diverticulum in relation to or just above the growth rather than a biopsy perforation, especially seeing that the biopsy was taken from the *lowest* edge of the growth as it presented to the sigmoidoscope.

Other possible complications of biopsy, such as any form of acute perirectal infection, have been considered, but no instance has been observed, so far as we can ascertain, at St. Mark's Hospital. Nor has any case been noted in which development of a rectovaginal fistula has appeared to be precipitated by a biopsy: this is probably due to the fact that a biopsy has almost invariably been taken from the margin rather than from the base of an ulcer. We mention this because we can recall several cases of radium reactions on the anterior rectal wall in which a biopsy from the rectal aspect was considered but was rejected owing to the risk of causing a recto-vaginal fistula. In the male there has been no example of a recto-vesical or recto-urethral fistula following rectal biopsy.

THE PREPARATION OF BIOPSY FRAGMENTS FOR MICROSCOPICAL EXAMINATION

Biopsy fragments may be dealt with by any of the usual methods employed for preparation of sections, but since in so many cases it is desirable to get the report through as soon as possible we now use the following rapid method as a routine. The biopsy fragments are placed at once into 10 per cent formalin and sent in this solution without delay to the laboratory, where they are removed from the

formalin solution, washed in 2 per cent sodium acetate, and placed in Carnoy's fluid* for one hour. They are then washed in two or three changes of 96 per cent alcohol and finally in absolute alcohol. From this they are transferred to chloroform and left in this overnight. Next morning the fragments are placed in paraffin wax in the 58° C. oven, from which they are transferred to the vacuum embedding oven for one hour. The blocks are then cooled and the sections cut and stained in the usual way.

The adoption of this routine makes it possible to report on a biopsy on the day following its receipt, in most cases within 24 hours. Thus if the biopsy is received at the laboratory in the early afternoon the fixation and dehydration are commenced at once, the fragments are left in chloroform overnight and sectioned and stained early next morning, being ready for examination by midday.

FIG. 566. — Biopsy fragment showing normal mucosa above (cut transversely) and carcinoma below. To illustrate contrast between benign and malignant tissue. (× 12.)

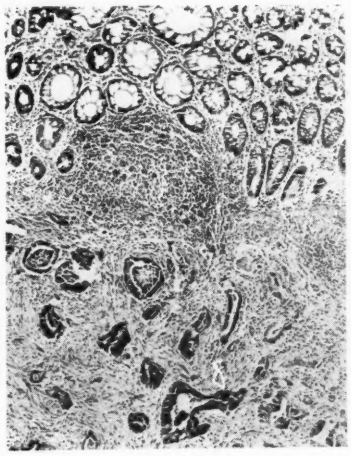

FIG. 567.—Biopsy fragment showing normal rectal mucosa above (cut obliquely) and carcinoma invading submucosa below. (× 42.)

FIG. 568.—Biopsy showing permeation by solid clumps of carcinoma cells of vascular and lymphatic channels in submucosa. (× 84.)

1. Diagnosis of Malignancy

Rectal biopsy is useful both for the confirmation of a diagnosis of malignancy and the elucidation of a lesion which is clinically obscure. We shall consider these in turn.

Interpretation of Biopsies undertaken for the Diagnosis of Malignancy.—If satisfactory biopsy fragments have been obtained it is generally quite easy by microscopical examination to distinguish between an inflammatory and a neoplastic lesion, but often not so easy to decide whether a tumour is benign or malignant. It would be out of place in a paper such as this to discuss all the histological details which may need to be considered when distinguishing between benign and malignant tumours: we shall refer only to the two most important, namely the atypical appearances of tumour cells and their position. A diagnosis of malignancy can always be made with confidence if atypical undifferentiated cells are misplaced and found to be infiltrating or invading surrounding structures. Evidence of this kind is often obvious in sections of rectal biopsies because the fragment removed may include both tumour and adjoining mucosa. *Fig.* 566 illustrates such a case, and it will be noticed at once that the contrast between malignant and normal tissue is striking.

The interpretation of biopsy sections is relatively easy also if they show direct spread into the submucosa or muscle as in *Fig.* 567. Evidence of indirect spread within submucous lymphatics or venules may also be found in a biopsy fragment. In the case illustrated in *Fig.* 568 a small cluster of carcinoma cells is seen in a small vessel, either a lymphatic channel or large capillary, within the submucosa.

So far we have considered only cases in which the diagnosis of malignancy could be supported by evidence of infiltration or invasiveness. The interpretation of a biopsy may be more difficult if the sections only show small fragments of the tumour itself and do not include any surrounding tissues. Then the diagnosis of malignancy must be based

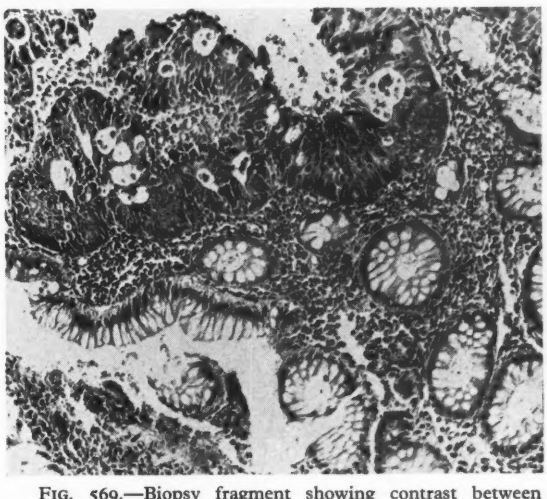

FIG. 569.—Biopsy fragment showing contrast between cytology and arrangement of carcinoma cells above and normal mucosa below. (× 80.)

* *Formula for Carnoy's Fluid*: Absolute alcohol, 60 c.c.; Chloroform, 30 c.c.; Glacial acetic acid, 10 c.c.

only on the cytology and arrangement of the tumour cells (*Fig.* 569). Under these circumstances much depends on the histological variety and grade of malignancy of the tumour. For instance, an anaplastic carcinoma of a high grade of malignancy is relatively easily recognized as malignant, but it may be much more difficult to distinguish between a well-differentiated adenocarcinoma of a low histological grade of malignancy and a benign adenoma. We have endeavoured to illustrate these points in *Figs.* 570–573, which are all from biopsy sections which happen to include tumour tissue only. It will be seen that the histological characteristics of malignancy are obvious at once in an undifferentiated adenocarcinoma (*Fig.* 570). The same is true for a colloid carcinoma of the signet-cell type (*Fig.* 571) and an anaplastic carcinoma simplex (*Fig.* 572). On the other hand, a well-differentiated adenocarcinoma of a low grade of malignancy may be difficult to recognize as malignant (*Fig.* 573).

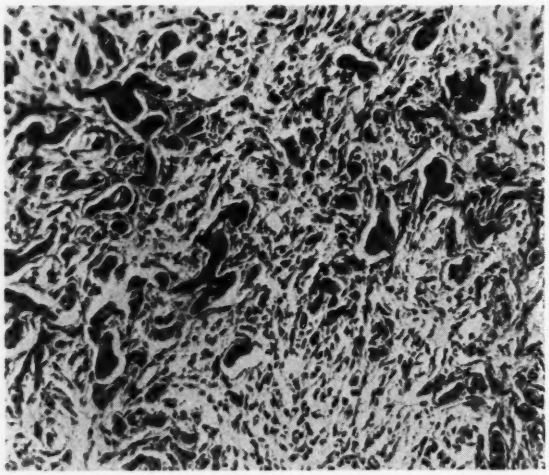

FIG. 570.—Field from biopsy section showing only undifferentiated adenocarcinoma of high-grade malignancy. (× 176.)

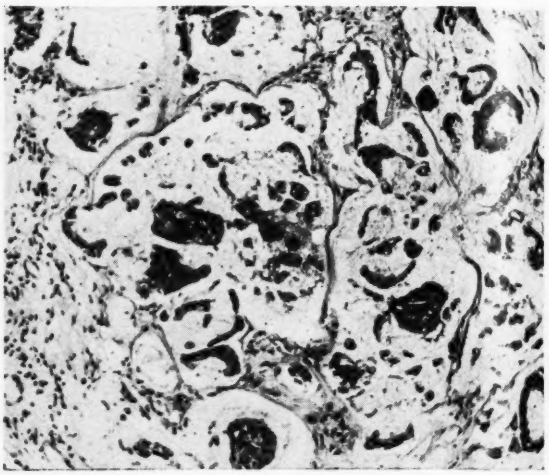

FIG. 571.—Biopsy fragment from colloid carcinoma showing clumps of carcinoma cells lying in mucoid material in submucosa. (× 92.)

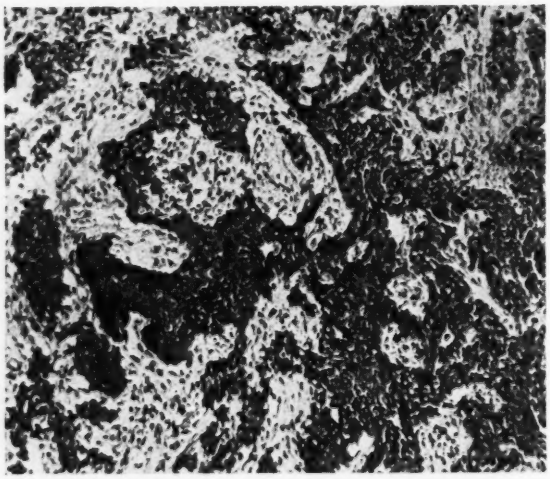

FIG. 572.—Field from biopsy section showing anaplastic carcinoma simplex infiltrating submucosa. Note absence of any glandular arrangement. (× 112.)

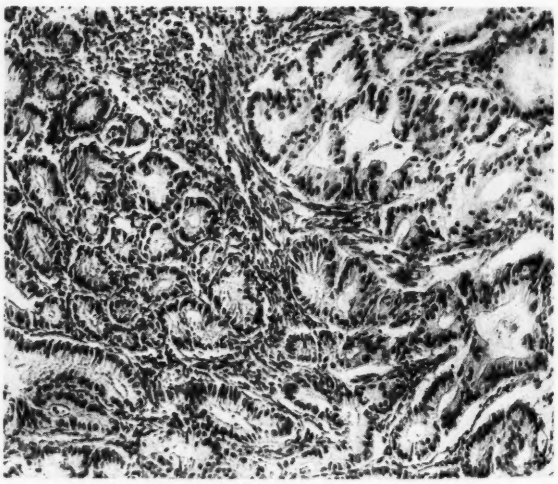

FIG. 573.—Well-differentiated adenocarcinoma of low grade of malignancy: difficult to recognize as malignant without evidence of infiltration. (× 80.)

We have proceeded from the easy to the difficult, and now come to what for most pathologists will be the hardest problem of all—namely, the biopsy detection of a focus of malignancy in a large fungating villous papilloma. These tumours may be so large and give rise to so much bleeding and mucous discharge that they may need radical excision of the rectum whether histologically benign or malignant, but in other cases the question of possible malignancy may be a deciding factor in treatment. On this issue we should like to make our position as plain as possible. Looking back on a long experience we can recall cases of malignant papillomas in which repeated biopsy failed to reveal malignancy though this was certainly present, and one of us (C. E. D.) can also recall a case in which he misinterpreted the histological picture and reported as 'malignant' a tumour which was subsequently proved to be benign. None the less there have been many other cases in which biopsy has proved to be a valuable aid to

diagnosis and we should certainly recommend its use, with the reservation of course that the responsibility for the final decision must rest with the surgeon and not the pathologist.

In interpreting the biopsy fragments from a malignant papilloma it must first be recalled that some of the pieces will show only the familiar structure of a villous papilloma (*Fig.* 574), but amongst these there may be some bits which show definite malignancy. A pathologist may need to examine several sections of such a biopsy before making up his mind. If he remains undecided he should always give the patient the benefit of the doubt and report

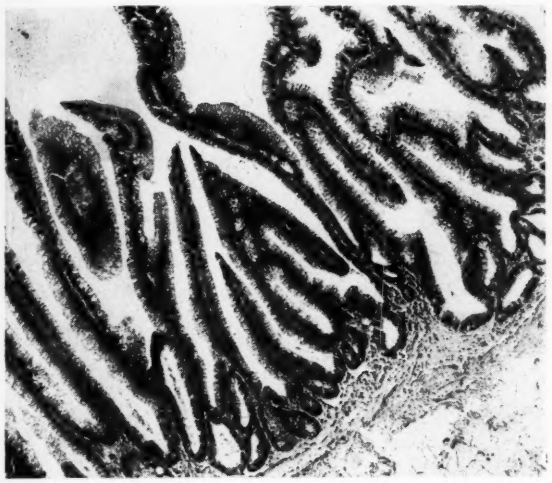

FIG. 574.—Portion of biopsy from a malignant papilloma. This field shows only benign villous papilloma. (× 40.)

that " no definite evidence of malignancy has been found ".

If the first sections from a tumour suspected to be malignant prove to be inconclusive, more should be cut at a lower level in the block. It may even be necessary to cut right through the block because a section cut at one level may show a focus of carcinoma not visible at other levels. If nothing definite has been found in a biopsy from a case in which the clinical history or gross characters of the lesion suggest malignancy, then the biopsy should be repeated.

We now pass from carcinoma, the commonest variety of malignancy, to consider the place of biopsy in the diagnosis of rarer neoplasms such as sarcoma, endometrioma, and carcinoid tumours, and shall describe briefly our experience with each of these. We have met with cases of lymphosarcoma, leiomyosarcoma, fibrosarcoma, and melanotic carcinoma, all of which were diagnosed by biopsy. In most of these the histological picture was quite characteristic and the tumour was obviously malignant. Our difficulty has been not in the recognition of malignancy in a sarcoma or melanoma, but in excluding it in cases of benign tumours composed of lymphoid tissues : in such lesions the distinction between lymphosarcoma and lymphoma has been far from easy. The chief points of distinction are : First, that a benign lymphoma is generally a relatively small tumour, seldom large enough to cause symptoms. Secondly, that sections through a nodule of lymphoid hyperplasia or through a lymphoma always show some degree of differentiation toward the formation of germinal centres, though these may not be apparent in all parts. Thirdly, the distinction between lymphoma and lymphosarcoma depends ultimately on a careful study of the nuclear structure of the lymphoid cells,

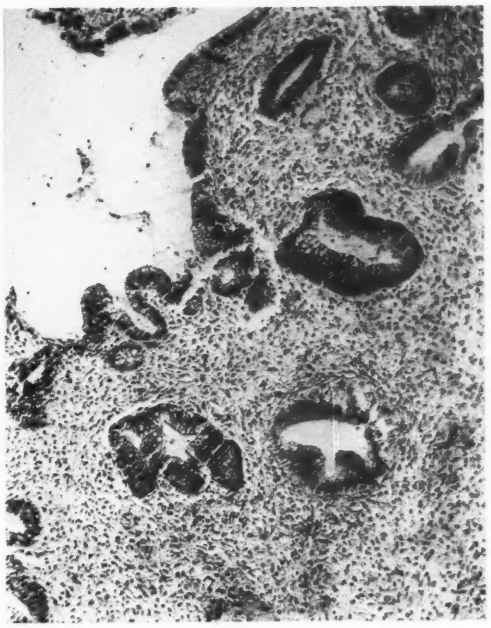

FIG. 575.—Biopsy from case of endometrioma of rectum. This was mistaken for a well-differentiated primary adenocarcinoma of the rectum from which it is almost indistinguishable. (× 80.)

and for this purpose properly fixed material and thin well-stained sections are essential. The surest indications of malignancy in lymphoid tumours are pleomorphism, hyperchromatic nuclei, and frequent mitoses. Unless there is convincing evidence of these the verdict with respect to malignancy should be ' non-proven '.

In all sarcomas of the rectum the tumour is first covered with intact mucosa, and this is true also of endometriosis or endometrioma. The biopsy diagnosis of a rectal endometrioma is particularly difficult because since the tumour invades the bowel from without it is unlikely that a biopsy will show more than a few scattered clumps of unusual-looking epithelium in the submucosa (*Fig.* 575). There is no difficulty, of course, in recognizing endometriosis when an operation specimen is sectioned, but in our experience it has been difficult to get satisfactory biopsy fragments for a pre-operative diagnosis. If when examining a biopsy section the possibility of endometrioma is not taken into account, the lesion may be reported as " some form of malignancy ". A pathologist who is asked to report on a section from a lesion suspected of being an endometrioma should be told of the clinical diagnosis so that he may make a special search for the loose cellular stroma which so characteristically surrounds the glands in endometriosis (*Fig.* 576).

Carcinoid tumours are not uncommon in the rectum, but they seldom become large enough to

cause symptoms. Most of those which we have come across have been either incidental findings during sigmoidoscopy or in operation specimens removed for other lesions (*Fig.* 577). Carcinoid tumours vary in significance in different regions of the bowel. When situated in the appendix they grow slowly and very seldom metastasize. In the small intestine and colon they appear as annular constricting growths which quite commonly are found to have given rise to lymphatic or hepatic metastases. In the rectum carcinoid tumours generally cause small, rounded, sessile, or pedunculated lesions resembling adenomas in appearance, but we have never met with one which could not be removed by local excision. We have kept a close follow-up on cases treated in this way and have not yet met with any local recurrences.

FIG. 576.—Section from operation specimen of endometrioma showing endometrial glands surrounded by loose cellular stroma within submucosa of rectum. (× 80.)

We have now described the different varieties of malignant tumours which may be revealed by rectal biopsy and illustrated the special points to be kept in mind in the interpretation of sections from each of these, and now pass on to discuss the reliability of biopsy as an aid to the diagnosis of malignant tumours.

Accuracy of Biopsy Diagnosis of Malignancy.—Before giving figures to show the accuracy of biopsy diagnosis we must first point out that the frequency with which a biopsy proves to be ' right ' or ' wrong ' does not depend only on the judgement and experience of the pathologist who examines the sections. It depends also to a greater extent than is usually appreciated on the skill of the surgeon. Although the taking of a biopsy is not a difficult procedure if the right instruments are used, yet none the less considerable experience is necessary to obtain really satisfactory bits, in proof of which we may mention we have noticed that ' inconclusive ' reports tend to be relatively more common when a new registrar or clinical assistant first comes to work at the hospital. For these reasons in the following analysis we have limited the cases to patients under the care of one of us (W. B. G.) who took the biopsy and later carried out the operation of excision of the rectum. The biopsy fragments were examined and reported on, then after excision of the rectum the whole tumour was examined and the pathological report completed without reference to the original biopsy diagnosis. In preparation for this paper we have searched through the records to find how often there was a discrepancy between the original biopsy diagnosis and the verdict after the subsequent more complete examination of the whole tumour.

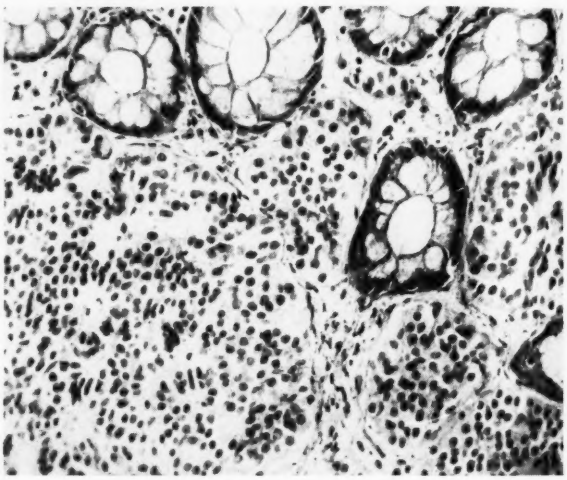

FIG. 577.—Biopsy from small carcinoid tumour of rectum showing characteristic clusters of carcinoid cells in mucous membrane and submucosa. (× 240.)

The series we have analysed included 670 cases of malignant tumours of the rectum and anus treated by radical excision during the period 1938–50. Of these, 650 were reported by biopsy as ' malignant ' and 20 as ' non-malignant '. In this series, then, the biopsy was right in 97 per cent of cases, but we hasten to add that we do not claim that such a high degree of accuracy in biopsy diagnosis would be reached at once by others new to this work. Our experience shows what can be achieved when initial difficulties have been overcome: by graduates, so to speak, in the school of biopsy diagnosis. Certainly the figures prove that biopsy is a reliable procedure for confirming the diagnosis of malignant tumours in this region. As further evidence for this conclusion we may mention that the taking of a pre-operative biopsy has now been adopted as a routine by all other surgeons working at St. Mark's Hospital.

Limitations of Biopsy in recognition of Histological Varieties and Grades of Malignancy.—So far we have discussed only the diagnosis of malignancy, but biopsy might be of value also in distinguishing the histological varieties of malignancy already mentioned. Carcinoma, sarcoma, and carcinoid tumours are very distinct in their histology, and rectal cancer may be further subdivided into adenocarcinoma, colloid carcinoma, and anaplastic

carcinoma simplex. Similarly carcinoma of the anal canal may be divided into squamous- and transitional-cell varieties. These all differ to some extent in their rate of growth and liability to metastasize, and it would therefore add to the value of a biopsy report if it were possible not only to establish the fact of malignancy but also to specify correctly the histological variety.

When we came to look through our records to compare the biopsy reports with those on the subsequent operation specimens we found that adenocarcinoma of the rectum, squamous-cell carcinoma of the anal canal, and sarcoma were almost

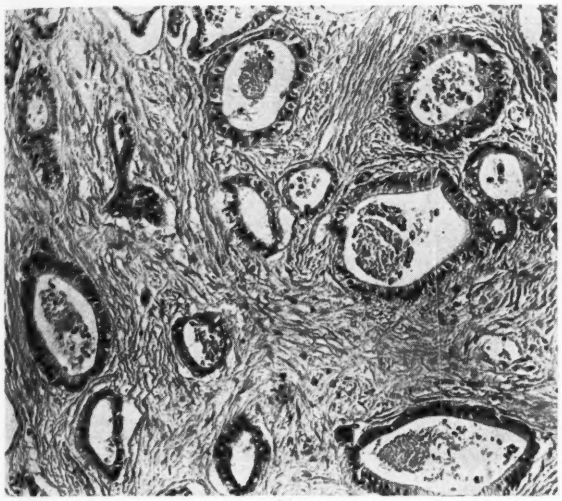

FIG. 578.—Adenocarcinoma : low-grade malignancy. (× 116.)

invariably correctly recorded as such in the pre-operation biopsy report, but in the case of colloid carcinoma and anaplastic carcinoma simplex there were many discrepancies. No difficulty was experienced in recognizing these tumours as malignant, but many colloid carcinomas were reported as adenocarcinomas and there was a tendency to describe the anaplastic carcinoma simplex tumours by the non-committal term ' some form of malignancy '.

We have made a similar comparison between the biopsy and the operation reports to ascertain the reliability of pre-operative grading of tumours. Since the histological group ' adenocarcinoma ' constitutes such a large proportion of all rectal cancer, it is convenient to subdivide it on the basis of the degree of differentiation of the tumour cells into three subgroups : (1) low grade of malignancy (*Fig.* 578) ; (2) average grade (*Fig.* 579) ; and (3) high grade of malignancy (*see Fig.* 570). This is worth doing because the examination of operation specimens has shown that the incidence of lymphatic metastases varies in these subgroups, being less than 20 per cent in adenocarcinomas of a low grade of malignancy and more than 70 per cent in adenocarcinomas of a high grade of malignancy. It would, therefore, be an advantage if the grade of malignancy of an adenocarcinoma could be ascertained before operation by means of biopsy diagnosis.

Unfortunately this can only be done with accuracy in a small proportion of cases. When we came to look through our records we found that the tumours reported by biopsy as of a low grade had often proved later to be of average grade, and many reported as of average grade were subsequently found to be of a low or even high grade of malignancy. It would seem that the chief value of the grading of biopsy

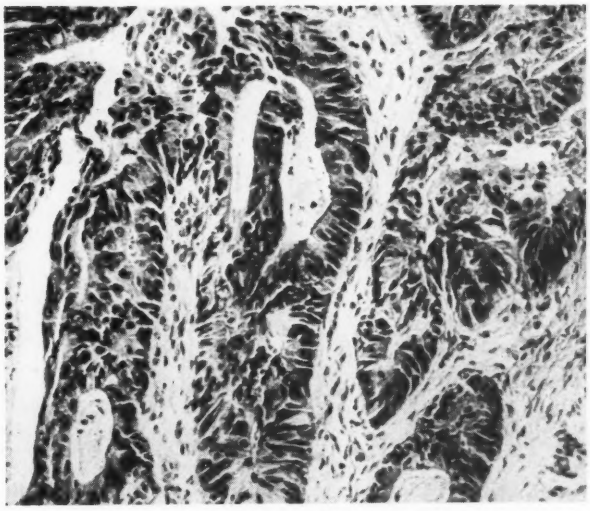

FIG. 579.—Adenocarcinoma : average-grade malignancy. (× 144.)

fragments lies in the recognition of tumours of a high grade of malignancy. There was less discrepancy in this group than in the others and it seldom happened in this series of cases that a biopsy estimate of ' high-grade malignancy ' was not substantiated when the operation specimen was examined later.

Although a biopsy section does not always reveal correctly the histological variety of a carcinoma or its grade of malignancy, it cannot be said that this

FIG. 580.—Biopsy from granuloma of rectum showing cellular granulation tissue covered by thin fibrinous exudate. (× 88.)

detracts seriously from its value to the surgeon. In most cases the surgeon simply wishes to know whether the tumour is innocent or malignant and, as already stated, in this series this question was answered correctly in 97 per cent of cases.

2. Non-Malignant Lesions

Rectal biopsy has a very important place also in the elucidation of a rectal lesion which is clinically obscure. Localized inflammatory and infective lesions of a granulomatous nature may often be diagnosed correctly by biopsy (*Fig.* 580). Ulcers in the anal region are notoriously difficult to diagnose clinically, tuberculous ulcers in particular being hard to distinguish from early squamous-cell carcinoma. But the biopsy picture of these lesions is quite characteristic, as can be seen from *Figs.* 581, 582. Another lesion easily recognizable by biopsy is a paraffinoma resulting from the injection of non-absorbable oil for the treatment of hæmorrhoids. Sections from such a lesion show a collection of cysts surrounded by fibrous capsules situated mostly in the submucosa (*Figs.* 583, 584). We have come across cases also in which biopsy has been useful in the diagnosis of intestinal pneumatosis, a rare condition in which cysts containing air are present in the mucous membrane and submucosa. We have records also of cases of rectal ulceration proved eventually to be due to amœbic dysentery, tertiary syphilis, and lymphogranuloma venereum in which biopsy gave a clue to diagnosis, and of other cases of fibrous stricture in which biopsy proved that the lesion was inflammatory and not neoplastic in character. This is not in any way a complete list of all the rectal lesions in which biopsy might be useful, but only

Fig. 581.—Biopsy from tuberculous ulcer of anal canal. (× 72.)

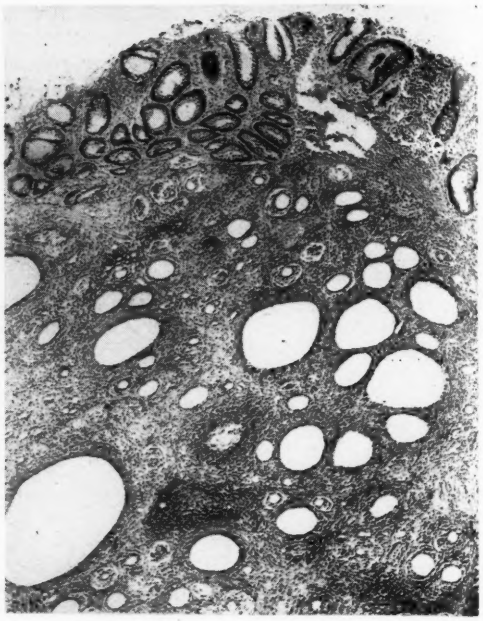

Fig. 583.—Paraffinoma of rectum. The cystic spaces within the submucosa contained non-absorbable oil and were surrounded by fibrous tissue. (× 32.)

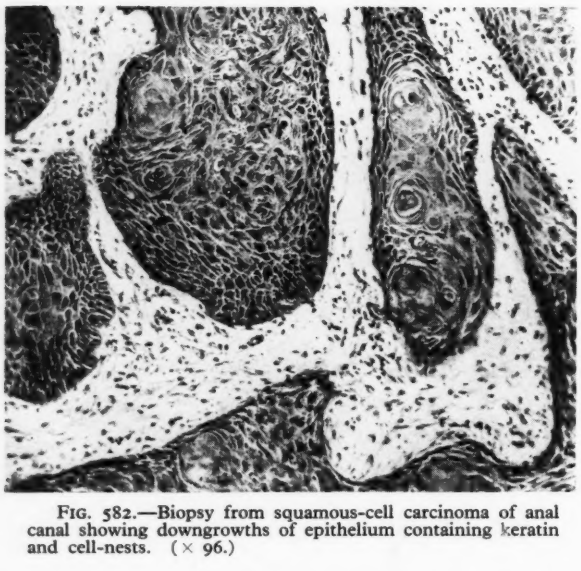

Fig. 582.—Biopsy from squamous-cell carcinoma of anal canal showing downgrowths of epithelium containing keratin and cell-nests. (× 96.)

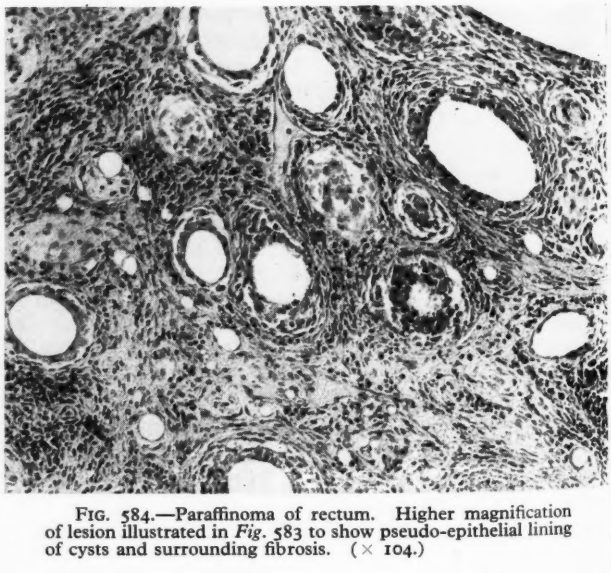

Fig. 584.—Paraffinoma of rectum. Higher magnification of lesion illustrated in *Fig.* 583 to show pseudo-epithelial lining of cysts and surrounding fibrosis. (× 104.)

those which we can recall from our own personal experience. We are convinced that in all these cases biopsy was an indispensable aid to diagnosis and a decisive factor in treatment.

SUMMARY

1. For more than fifty years biopsy has been used as an aid to the diagnosis of rectal tumours. During the last twenty years it has become a routine pre-operative procedure at St. Mark's Hospital, where more than 4000 biopsy sections have been examined in the pathology department.

2. The technique of biopsy is described and its possible complications considered.

3. A description is given of a rapid method whereby paraffin-blocked sections of biopsies may be prepared within 24 hours.

4. Difficulties experienced in the interpretation of biopsies undertaken for the diagnosis of malignancy are discussed very fully, the distinctive feature of different varieties of malignancy being illustrated by photographs of biopsy sections.

5. The accuracy in biopsy diagnosis which may be achieved by experience is shown by the fact that in a series of 670 cases of malignant tumours of the rectum and anus the pre-operative biopsy had reported malignancy in 650. In this series, then, the biopsy report was right in 97 per cent of the cases.

6. A biopsy section does not always reveal the actual histological variety or grade of a malignant tumour correctly, though anaplastic carcinomas of a high grade of malignancy can generally be identified by this means.

7. Rectal biopsy has an important place in the elucidation of lesions which are clinically obscure.

We acknowledge with gratitude the assistance we have received from all our colleagues at St. Mark's Hospital. The laboratory and photographic expenses involved in this work were met by a grant from the British Empire Cancer Campaign, for which we are most grateful.

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CHRONIC EMPYEMA

BY T. HOLMES SELLORS, LONDON, AND GORDON CRUICKSHANK, LEICESTER

FEW more discreditable chapters are to be found in the history of modern medicine than the treatment of chronic empyema. The disability produced by the persistence of a chronically infected pleural space is very grave, and unfortunately can only too often be attributed to some error or neglect in the early stages of pleural suppuration. Fifty years ago Stephen Paget (1896) wrote in this connexion: "One might add a score of cases to show that an unhealed empyema is, as a rule, the direct result of the patient's neglect, or of the surgeon's delay, or of inadequate and useless surgery; but our business now is to inquire how we may most surely and safely cure it."

There has undoubtedly been some improvement in the position during the last half century, but thoracic surgeons are still called upon to treat a number of chronic empyemata apart from those who linger on unattended and unhealed.

The present series from the experience of two thoracic surgeons consists of over 600 cases of non-tuberculous empyema. Tuberculosis is excluded, as this condition is a problem on its own, behaving differently, and requiring differences of treatment.

Definition.—In any analysis of chronicity some definition is required, and we have accepted as a chronic empyema one "which after six to eight weeks is not making steady progress towards healing". This excludes the extensive cavity which is healing gradually and will obliterate in fullness of time, but includes those where the healing is stationary.

Any discussion on chronic empyema is closely linked up with the trends in the treatment of acute pleural infection. These have fluctuated from the days of Hippocrates between early and late removal of the products of inflammation; in other words there has been a periodic swing between early drainage for the removal of pus and delayed drainage only undertaken after the abscess has localized. Within recent memory the influence of Evarts Graham's work on the advantages of delayed or lost drainage has had considerable significance. The influenzal or streptococcal pandemic of 1918 had shown the extreme dangers of early drainage with an open pneumothorax when the pulmonary inflammation had not resolved, and consequently aspiration with delayed drainage was accepted with some justice. Nevertheless, the inability of many physicians and surgeons to realize that treatment of an empyema is something more than resecting a rib and inserting a tube, has been all too common. Failure to appreciate the time of localization of the pleural abscess, failure to drain in the right place, failure to drain adequately, and above all, failure to observe the process of healing, have contributed to the chronic state. Basic principles have been ignored time and time again, and the division of responsibility between physician and surgeon has often been unfortunate for the patient.

The advent of chemotherapy has in many ways changed the whole face of pleural infection, partly because pneumonic conditions may be relatively minor incidents, and partly because efficient chemotherapy will sterilize infected pleural contents in a high proportion of infections. But though drainage and chemotherapy may eliminate the toxic element of the infection, they will not of their own account obliterate the abscess cavity. In other parts of the body the soft tissues close in on the abscess cavity, but in the chest with its rigid thorax, the elastic lung falling away from the chest wall, the tendency towards the maintenance of an open cavity is obvious.

This persistent dead space or cavity has to be observed during the whole process of its closure, which normally takes place by re-expansion of collapsed lung and by granulation tissue forming at the empyema margins and helping the process of creeping in.

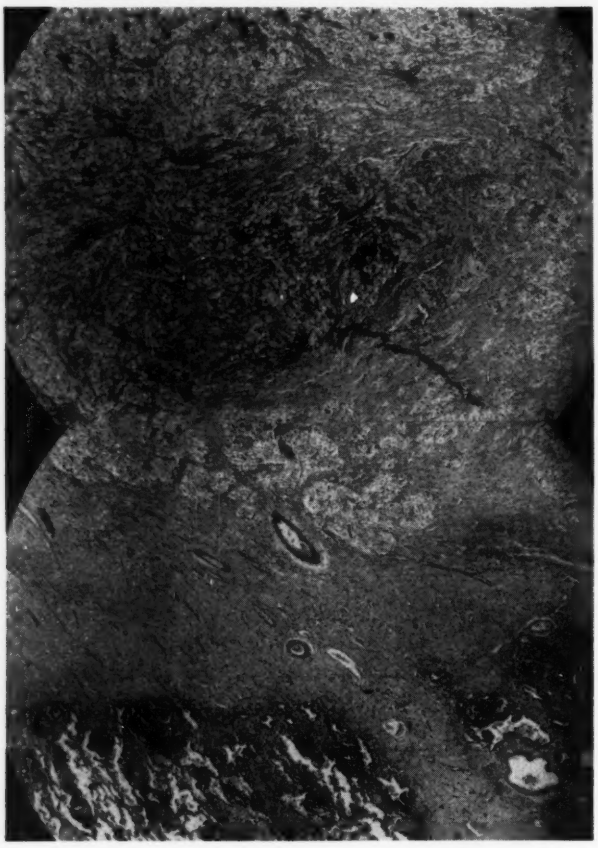


FIG. 585.—Section through visceral pleura in a case of chronic infection. Note nests of foamy phagocytic cells which are probably laden with lipiodol which has been used in the pleurograms. At the bottom of the picture some lung tissue is visible and the varying degrees of organization on the fibrous tissue close to lung and its more open appearance towards the surface can be seen. (× 24.)

FIG. 586.—Section of parietal pleura showing collagen fibres and fibrin on the surface, with deeper organization and at the bottom collections of plasma cells and lymphocytes which are probably due to trauma, e.g., instruments, heat, or drying. This, on occasions, can be confused with oat-cell carcinoma. (× 80.)

THE MATERIAL

The series of chronic empyemata now under discussion have been collected during the past twelve years and have been personally treated in certain general hospitals as well as in the chest units to which the authors have been attached. The incidence has changed considerably with the progress of time, the number seen ten to twelve years ago being very much greater than during the past four years. For example, at one chest unit during a period taken at random eight years ago, almost 50 per cent of the patients were subjects of chronic pleural infections, while recently in the same unit there were only 5 examples out of 70 non-tuberculous surgical chest patients.

The material reviewed consisted of cases of chronic empyemata of pyogenic origin. Obvious tuberculous infection was excluded, as also patients who had been subjected to thoracic operation or who derived their infection as a result of war injury. The reason for the exclusion of chest operation cases is that, prior to chemotherapy, lobectomies and pneumonectomies were routinely drained until the dead space had healed. If the chronic empyema was a secondary consideration in some much more obvious disease (cancer) it was also rejected, though examples in which the actual cause of the empyema was only recognized after detailed investigations were accepted.

PATHOLOGY

(*Figs.* 585–588)

Singularly little has been recorded on the pathology of pleural infections and we have made

investigations to try and establish some points concerned with morbid anatomy.

The normal pleura consists of a single flat endothelial layer lying on a thin fibro-elastic sheet. Deep to this is a connective tissue zone containing blood-vessels and lymphatics with a well-formed and important deep fibro-elastic layer. On the lung surface this deep fibro-elastic layer dips into the fissures between the lung lobules and is in close association with pleural veins and lymphatics. On the parietal pleura the deep fibro-elastic layer gives off septa which mingle closely with the intercostal bundles, and it seems probable that the plane of dissection, the so-called endothoracic fascial layer, lies external to this elastic sheet. At the onset of pleural inflammation there is considerable thickening of the connective tissue layer between the fibro-elastic sheets as the result of œdema, and there is an exudate with a varying fibrin content into the actual pleural cavity. The deep fibro-elastic layers afford a very strong pathological barrier to infection and ordinarily prevent spread of the process beyond the pleural membrane. The effusion within the pleural cavity contains bacteria and deposits fibrin upon the pleural surfaces. This is an uneven deposit tending to lie more on the parietal than visceral surface and indeed in the chronic condition the parietal fibrous deposit is three to four times as thick as that on the surface of the lung. As time progresses the deposited fibrin shows vascularization close to the pleura and this fibrin tends to organize so that within two to three weeks the condition shows as layers of collagen arranged parallel to the pleural surface with a number of small blood-vessels along the adventitia of which the primitive fibroblasts develop. Close to the surface the fibrin loses its laminated character and becomes amorphous, with irregular fibrin masses and inflammatory cells which merge into loose or barely attached fibrin and pus cells within the abscess.

In long-standing cases a number of comparatively deep-seated histiocytes may be found, and it seems probable that these and some associated foreign-body giant cells are the results of radio-opaque oil (lipiodol or neo-hydriol) which may have been used in pleurograms. What appears to have happened is that the macrophages on the surface have taken in the oil and rapidly become buried under the fibrin, so that these oily deposits appear as deep-seated elements in the structure. In the majority of virulent affections, notably those of streptococcal origin, fibrolysin tends to reduce the amount of fibrin that is deposited; it is well known that the walls of such an empyema are much thinner than those in pneumococcal infections. Streptokinase has been injected into empyemata to try to reduce the fibrin. If penicillin has been used to sterilize the abscess it would appear that fibrolysin may be destroyed along with the bacteria, and this results in a relatively greater increase of fibrin and consequent thickness of empyema walls.

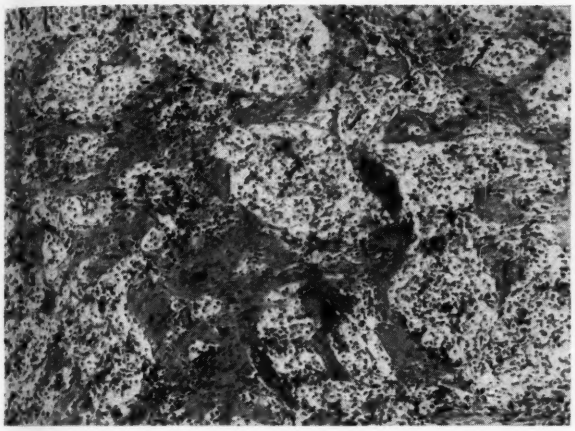


FIG. 587.—Nests of foamy phagocytic cells in the fibrous thickened pleura. These probably contain lipiodol. (× 80.)

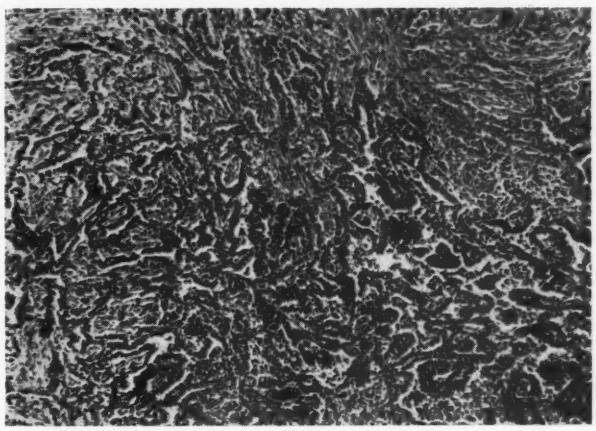


FIG. 588.—Section of pleura showing deposit of adenocarcinoma. The diagnosis was not established by any other method. (× 24.)

As time progresses the deep layers close to the true pleura show organized fibrous tissue and undergo cicatrization. This cicatrization may be extreme in the case of certain infections, notably tuberculosis, where the term 'constrictive pleurisy' would appear to be appropriate.

The next result of unrelieved infection is that the chest wall is dragged open by the parietal pleural scarring and the lung is bound down by a rigid sheet of tissue which hinders its re-expansion. In the chest wall itself, a number of changes take place. The ribs become approximated and the position of expiration is exaggerated. The actual shape of the ribs themselves becomes altered and on cross-section they appear triangular with a narrow superficial base and a sharp apex directed inwards. The intercostal muscles become scarred and contracted and a secondary scoliosis of greater or less degree results. The deformity of the spine is characterized more by lateral curvature than by a rotation of the spinal bodies. It is a deformity with a concavity of the spine towards the side of the lesion, the reverse of that seen after thoracoplasty. A curve of up to 30° may not be noticed with the patient clothed, and until this figure has been exceeded the rotation of the individual vertebræ and gross deformity does not become marked; nevertheless the flattened contracted chest coupled with the spinal deformity is sufficient evidence in itself of the disability that can be occasioned by chronic pleural infection (*Fig.* 589).

It may be added that in the chest wall the intercostal vessels become tortuous and much more friable than normal. This factor is important in any operation on a chronic empyema. Calcification is not as common as might be supposed and is probably rare in the absence of tuberculous infection. Ossification is sometimes encountered, when it is possible that the aspirating needle may have carried

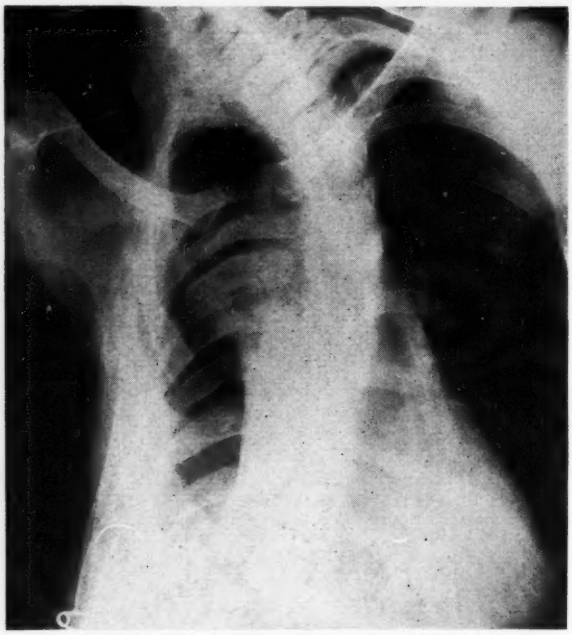


FIG. 589.—Long-standing chronic empyema showing extreme contracture of the hemithorax and severe secondary scoliosis.

bone-cells from rib or periosteum into the cavity at some time or other.

When an infected pleural cavity is drained and the contents (pus and loose masses of fibrin) are evacuated, the lining of the cavity is slightly roughened but not shaggy or irregular. A drained cavity has a smooth rigid lining, which is slowly absorbed if active movements are successful in expanding the lung. The cavity obliterates from the margins as the lung moves outwards, but with varying rapidity; the base of the lung expands more readily than the apex. If the chest wall and lung continue to move and function adequately the thick layer of fibrous tissue left by the fusion of the two pleural surfaces gradually absorbs until in some cases only a few strands of fibrous tissue are left to show the extent of the infection. This, however, does not always take place and if re-operation is needed it is found that adhesions vary between the thin type described and a firm rigid barrier uniting lung to chest wall.

INCIDENCE
(*Table I*)

Men are affected more than twice as frequently as women, and the chronic empyema appears to occur more frequently in early adult and adult life than at any other times. The duration of the condition has an important influence on treatment since cases with a short history have a more satisfactory response than those in which prolonged infection has produced a rigid cavity.

Table I.—CHRONIC EMPYEMA: GENERAL FIGURES

MALE	437	622
FEMALE	185	
RIGHT	332	621
LEFT	289	

(1 not recorded)

Age Incidence		*Duration*	
Under 3 years	23	2 to 3 months	89
3 to 10 years	29	3 to 6 months	324
11 to 20 years	71	6 to 12 months	76
21 to 30 years	119	1 to 5 years	91
31 to 40 years	124	6 to 10 years	17
41 to 50 years	115	10 to 20 years	17
51 to 60 years	81	Over 20 years	6
61 to 70 years	49		
71 to 80 years	11		
	622		620

Longest duration was 27 years; 2 not recorded.

CAUSATION
(*Tables II, III*)

Maltreatment of acute empyema is certainly the most potent factor in producing the chronic form, and analysis of our figures shows that the greatest proportion of cases were produced by mismanagement of the early stages. Out of 622 cases late or ineffective drainage was responsible for 448 chronic empyemata. An additional significant factor at the

Table II.—CHRONIC EMPYEMA: CAUSES
(622 *Non-tuberculous Cases*)

Late drainage	182
Wrong drainage	266
'Penicillin' empyema	79
Abscess or bronchiectasis	35
New growth	36
Actinomycosis	17
Foreign body	7
	622
Following operation	42
Association with subphrenic abscess	15
Association with liver abscess	4
Association with œsophageal fistula	2
Association with sloughed lung	6
Association with abscess of spinal origin	6

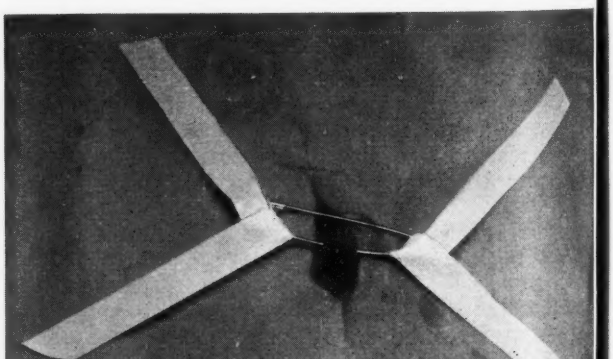
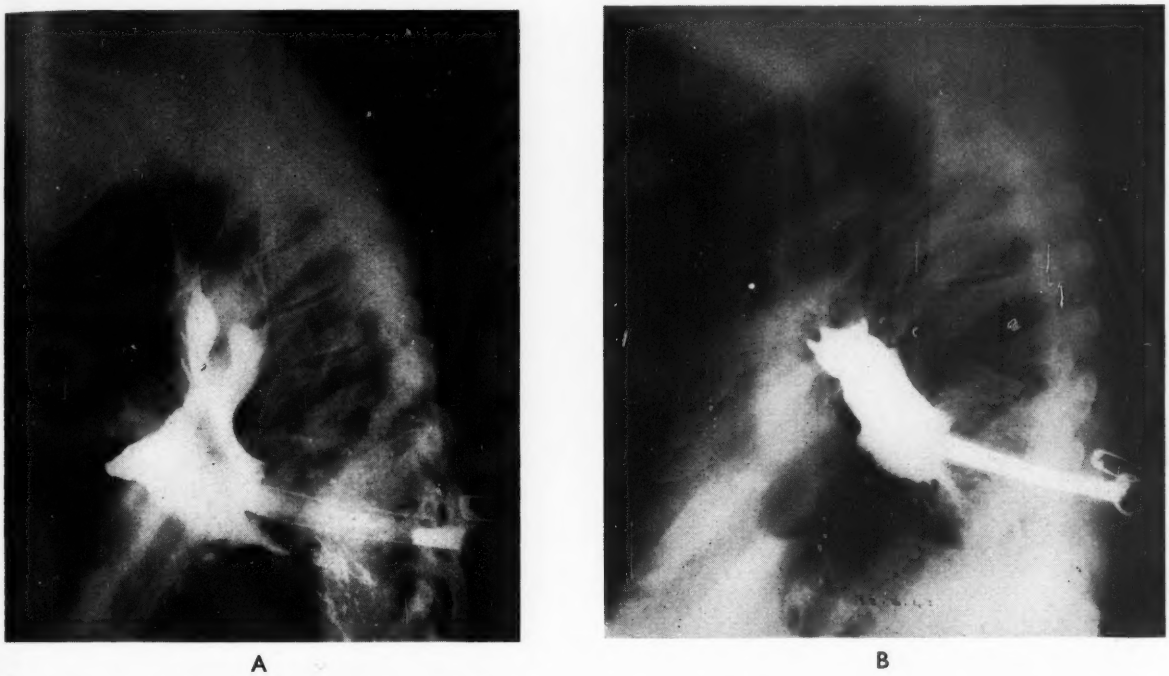


FIG. 590.—Method of retaining tube in position.

present time is the misuse of penicillin, which has added cases to the series.

The heading of *late drainage* or treatment included cases which have only been recognized at an interval after the acute stage, or which have been ineffectively treated in the early stages.



A B C

FIG. 591.—Serial pleurograms to show the process of healing. A, Shows tube entering the base of a large irregular pocket. B, The same tube with the pocket much smaller. C, The position just before the tube is fit to be removed.

Note: It is not usual to perform pleurograms with the tubes in place.

There is also the group in which empyema has been suspected but in which it has not been discovered. Frequently an unfortunate series of

Table III.—CHRONIC EMPYEMA: EXTENT AND SITE OF EMPYEMA
(622 *Cases*)

Basal or posterior	274
Anterior or axillary	73
Interlobar	48
Apical	46
Total	39
Tension	24
Multilocular	24
Mediastinal	3
Bilateral	9
	540
Unspecified or persistent unhealed tube tracks	82

circumstances leads to the delay, such as the patient not attending his doctor sufficiently early, the practitioner not establishing the diagnosis, or failure to aspirate the chest when fluid has been suspected. It is still a pity in many instances that aspiration is delayed, or that, when an aspiration has been performed and pus recognized, the logical sequence of removing the pus by aspiration or drainage, which constitutes proper handling of the case, has not been followed. Time and time again the case-history reveals that the patient was aspirated some time after an empyema was suspected, that a small quantity of pus was obtained, that several days elapsed before any further aspiration was undertaken, and that in an anxiety not to countenance too early drainage a deliberate period of delay was allowed, so that the patient when presented to the surgeon showed an already thickened pleura and a lung progressively being bound down.

Under the heading of *wrong drainage* come the errors committed by the surgeon rather than the

practitioner or physician. All effective drainage must be influenced by gravity so that no pools or pockets of pus are left below the drainage opening.

failure to recognize the more unusual forms of empyema, such as an anteriorly placed interlobar collection or an apical empyema.

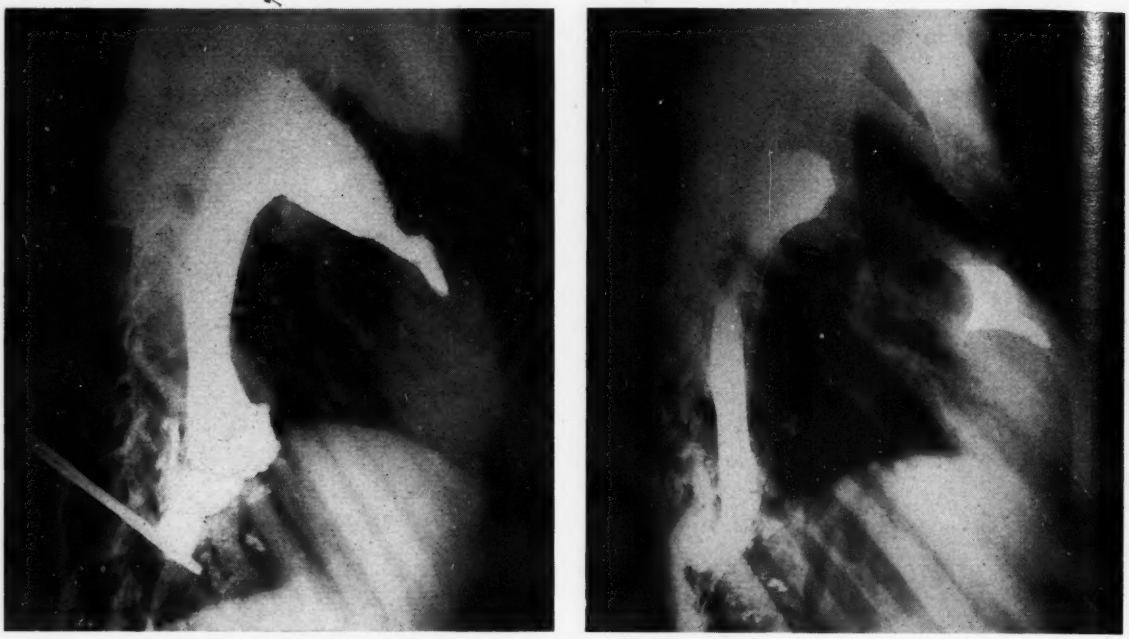
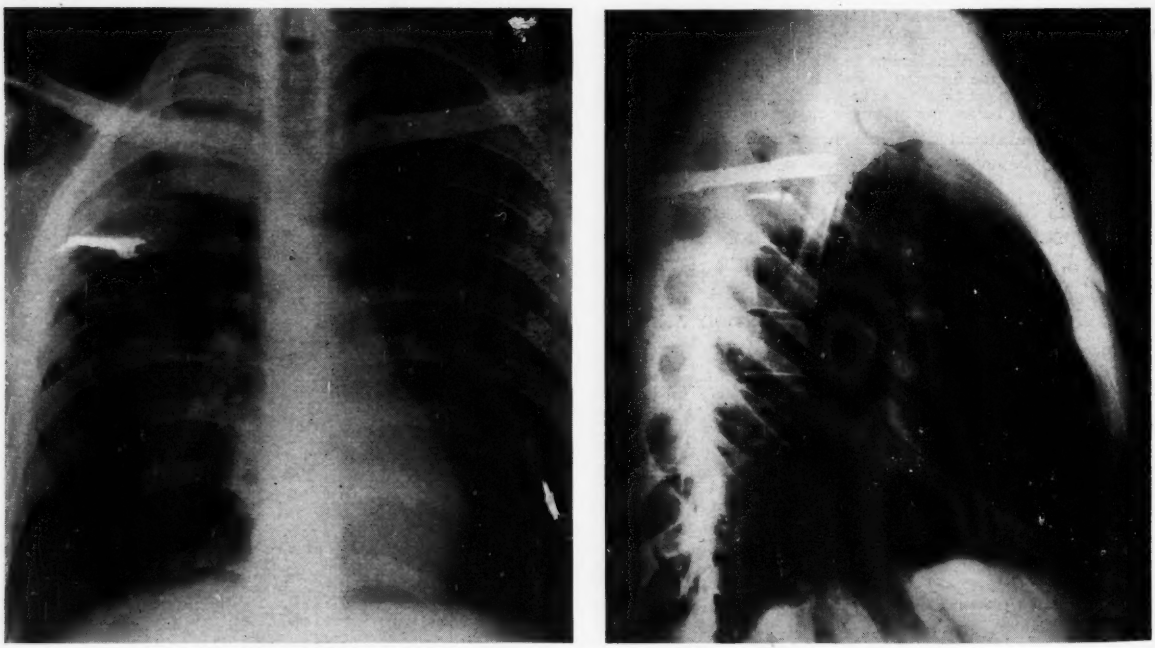


FIG. 592.—Large chronic empyema track extending upwards in the paravertebral gutter and over the apex. The anterior pocket will require careful watching during healing.



A B

FIG. 593.—Chronic right apical empyema. Anteroposterior view (A) shows lipiodol injected into cavity. Lateral view (B) shows correct position for drainage-tube.

The practice that was recorded in many text-books until recently, of draining an empyema in the axillary line, was responsible for a great many errors, since the paravertebral gutter, which is the most frequent site of an empyema, was left undrained. Draining too high is another common fault, as is

The most common error is definitely inadequate drainage, where the lumen of the drainage tube is too small or the operation opening is allowed to contract before the internal cavity has healed. It should be the absolute rule that no empyema which has been drained should be allowed to develop into

a big bulb or space with a tiny, narrow, and ineffective bottle-neck. In many hospitals it was common practice to remove the drainage-tube every day for cleaning and sterilizing before replacing. This in itself was responsible for many examples of inadequate drainage, for sooner or later replacement of the tube became uncomfortable and a smaller one was inserted—a process that was progressive over a period of weeks and months until what had been a wide-bore and effective drain was reduced to a narrow pin-hole sinus with maybe a pocket above. Associated with this error in nursing, which has, we trust, been largely eradicated, is the simple problem of holding a tube in position. A tube projecting beyond the skin's surface unfixed and impingeing upon dressings could only lead to discomfort, which in turn is often relieved by too early removal of the tube (*see Fig.* 590).

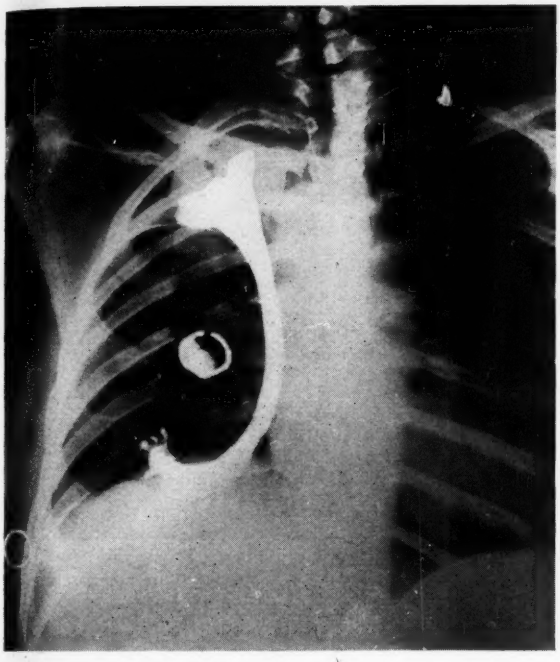


FIG. 594.—Right-sided chronic empyema track extending from base to apex with an anterior pocket which became shut off and required separate drainage.

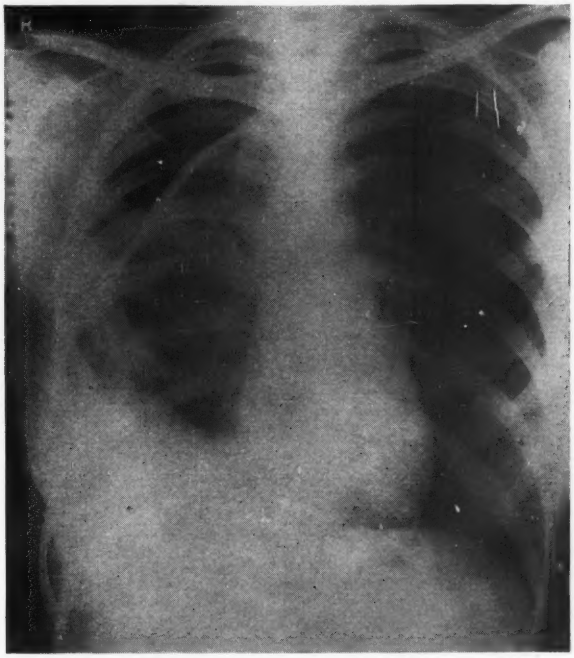


FIG. 595.—Right total empyema treated by basal drainage. The base has expanded quickly and shut off the tube from the rest of the cavity, which now has to be drained again. Note thickening of pleura over the lung.

The lack of adequate control of the healing process is another common cause of chronicity, for it is well known that in a large empyema the basal axillary expansion is quicker than in other areas. Too rapid expansion at the base may lead to the tube being shut off and the development of an apical pocket. Quick expansion in the axilla can lead to an inverted horseshoe type of track with an apical limb which is not drained by gravity. The obvious control of the healing process is by pleurograms—two plane radiographs taken after injection of opaque oil into the cavity (*Figs.* 591–598). The shape and extent can then be checked and an adjustment of the drainage-tube carried out; to insert a tube blindly within an empyema may lead to it becoming shut off from the main cavity by pockets and the like developing. Tube manipulation or re-drainage are the solutions to these problems. In the case of '*penicillin empyema*' it is again only fair to point out that its occurrence is not the responsibility of penicillin but of those who use it. In practically every one of our group of 71 cases penicillin had been injected into the cavity after aspiration of the contents, but this aspiration had not been adequate or thorough, and had been carried out at irregular intervals. If healing is to be expected in the acute diffuse stages of suppuration complete frequent and regular aspirations are every bit as important as the sterilizing effect of penicillin. In a badly treated case there is a thick-walled cavity with sterile contents of pus and fibrin masses which may be re-infected at a later date. Restriction of movement with all the signs of chest wall and pleural fibrosis is constant.

It was somewhat surprising to find that foreign bodies had contributed so little to causation; the 7 examples were those of retained drainage-tubes and other surgical misadventures (*Fig.* 599). There were in addition 3 examples of dead foreign tissue in the shape of sequestra of rib as a result of osteomyelitis, but 3 in the whole total is a very small proportion, and indicates the resistance of cut rib ends to infection.

Persistent underlying causes may become quite obvious when a chronic empyema is fully investigated, and it will be seen that pulmonary suppuration and new growth hold equal place with actinomycotic infections as the only other important conditions for comment. Cases in which tuberculosis was recognized, even though it was not apparent at the outset, have been excluded. The recognition of the somewhat unexpected causes may be determined by pleural biopsy or a more general investigation of the respiratory system; and the mention of pleural

biopsy is only to stress its importance when it is being discussed in a later section.

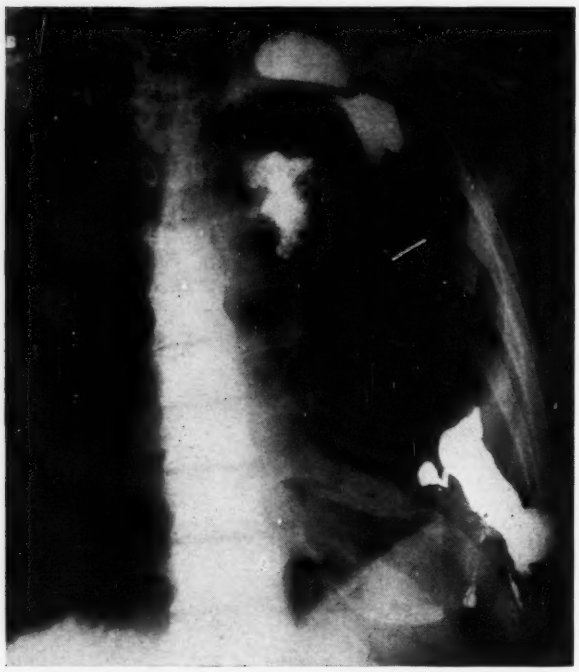


FIG. 596.—Left-sided chronic empyema with an apical and basal pocket due to re-expansion of the lung in the axilla. Note dragging up of diaphragm. Two drainage openings are acquired.

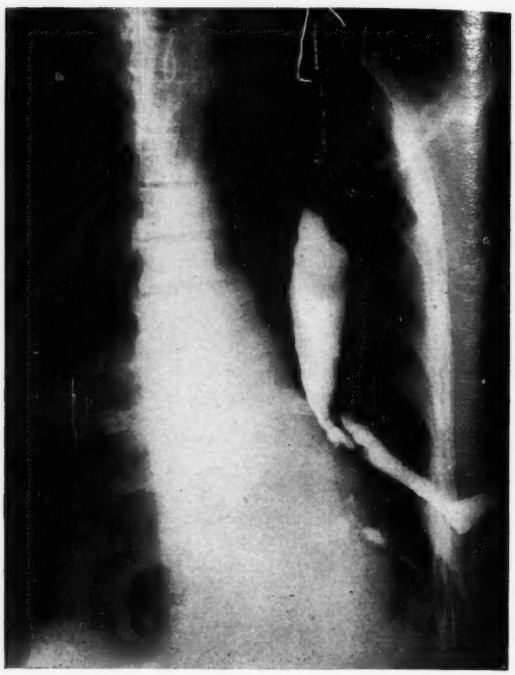


FIG. 597.—Left-sided empyema pocket which has nearly become shut off from the tube track. This bottle-neck will require dilatation and deeper insertion of tube.

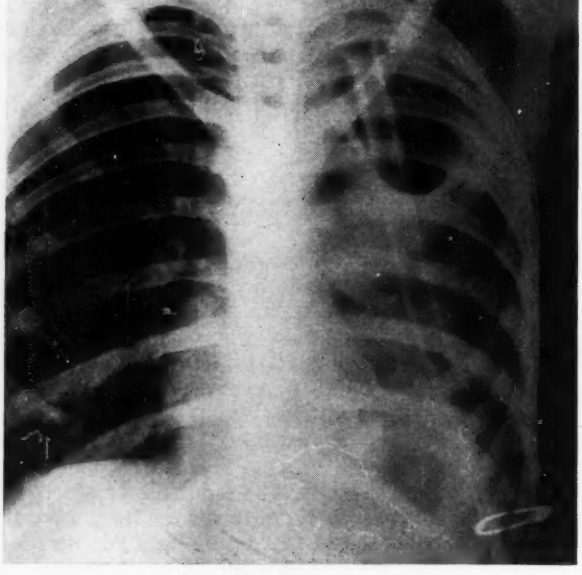


FIG. 598.—Left apical empyema resulting from rapid expansion of base. Drainage-tube has had to be advanced into the apical cavity. In this instance the tube was too long and should have been shortened by 1½ in.

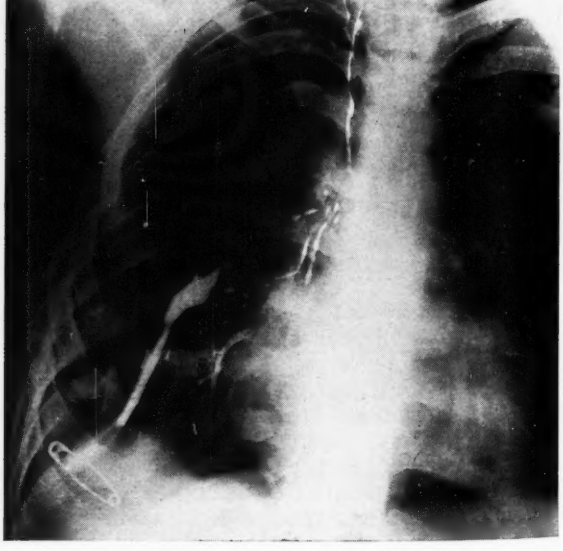


FIG. 599.—Right empyema tube track with bronchopleural fistula. In this case a small corrugated rubber drainage-tube was found (though this does not show well on the radiograph) and removed at a re-drainage operation.

A large series presents a number of additional points of interest on which a few comments may be made; e.g., an empyema following a subphrenic abscess either by rupture through the diaphragm or, as is more common, by the indiscreet use of the aspirating needle across the free pleural cavity, producing a most virulent form of total empyema which is often fatal in the acute stages; rupture of liver

abscess into the pleura or cavity may result in prolonged discharge of bile through the chest, but in general the course is uneventful if treated in the ordinary manner—the majority of liver abscesses rupture into lung rather than into the pleural space.

Paravertebral abscesses following on spinal osteomyelitis are liable to be serious complications, though the prognosis centres round the primary lesion. Empyema necessitatis is a familiar condition which is surprisingly rare when one considers how long pus may have been held shut up within a confined space, and suggests the powerful limiting action of the pleura. The alternative course for an empyema to break out is to rupture inwards into lung and to be coughed up through the resultant bronchopleural fistula (*Fig.* 600). A fistula was recognized in 41 of our cases, and though in some instances it effected a cure by evacuating the abscess, the danger of pulmonary infection is obvious if pus is being continually evacuated across the lung fields, and this spontaneous cure should never be regarded as anything but a matter of singular good fortune.

Rupture into the pericardium occurred in 4 instances and responded to prompt treatment. Other complications were not of sufficient frequency to need comment.

The most common situation for a chronic empyema is in the paravertebral gutter. These posteriorly placed cavities accounted for more than half of the recorded total (*see Table III*). Anterior or axillary abscesses had usually been overlooked at the time of original drainage, as opposed to apical empyemata which often resulted from more rapid expansion at the base producing a shut-off pocket during the healing process. Failure to localize pus with the aspirating needle accounted for the persistence of most of the interlobar collections. The presence of only 3 examples of mediastinal empyema indicate the rarity of this condition, and multilocular pockets were relatively uncommon.

Total empyema with almost complete collapse of lung constitutes a formidable problem, and to the 39 examples should be added 24 cases showing tension or pressure phenomena. The majority of these latter followed staphylococcal infections in children and babies and pursued a comparatively benign course, as compared with tension empyema produced as a result of ruptured subphrenic abscesses or anaerobic infections.

BACTERIOLOGY
(*Table IV*)

The virulence of the infection and the type of organism has a definite effect on the character of the effusion. In the chronic state the important feature is the fibrin content of the exudate, and certain bacteria, notably *pneumococci*, produce heavy deposits of fibrin, which in part organize on the abscess walls and in part lie in loose wads ('lymph masses') floating in creamy pus. Other organisms, such as *streptococci*, produce enzymes—fibrinolysins—which dissolve fibrin and leave the empyema with thinner walls and with fluid contents, and in consequence localization is less rapid and a more extensive form, such as a total empyema, is often found. Streptokinase is a fibrinolysin derived from streptococci and is used as a fibrin solvent in tuberculous meningitis and some forms of empyema.

Table IV.—Chronic Empyema: Bacteriology (Pure Culture)

Pneumococcus	106
Streptococcus	67
Staphylococcus	42
Sterile	36
Streptothrix	17
Anaerobe	8
B. coli	5
B. friedländeri	4
Ps. pyocyanei	4
Entamœba histolytica	3
B. necrophorus	3
B. influenzæ	3

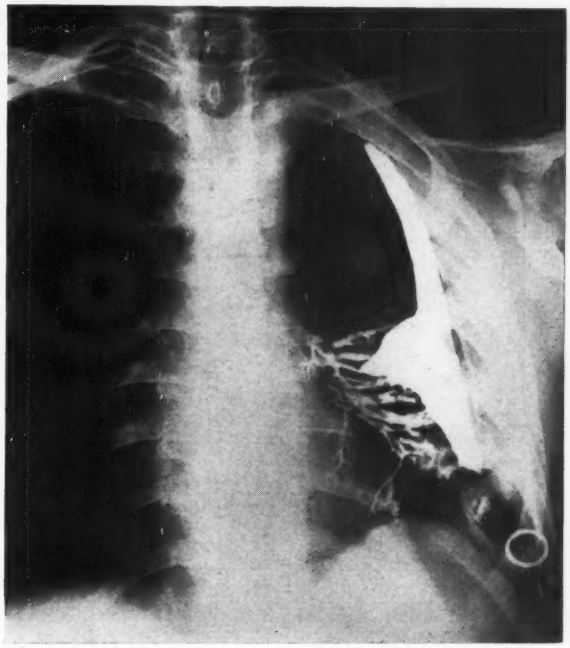


Fig. 600.—Left axillary empyema with multiple bronchial fistulæ. Note thickness of pleura lining the chest wall.

Staphylococcal infections lie midway between pneumococcal and streptococcal empyema as regards fibrin formation, but in children they may produce tension effects without undue toxæmia. An offensive odour may result from prolonged retention of pus, but usually *coliform* organisms, anaerobic streptococci, or clostridial bacteria are responsible, even though they may be difficult to identify on culture. *Bacillus necrophorus* is an interesting but rare infection which on each of the three instances gave a similar radiological picture resembling a multilocular interlobar effusion. *Amœbic* empyemata are due to rupture from a liver abscess through the diaphragm and give rise to red-brown offensive pus in which bile can be identified; two out of the three examples occurred on the left side.

Actinomycosis of the pleura had at one time a sinister reputation and if, in addition, the lung is heavily invaded, the classical picture of multiple discharging sinuses obtains. Most of the empyemata due to streptothrix respond to ordinary measures of treatment and cure was obtained by simple drainage before the introduction of penicillin.

Pus removed from a chronic undrained pleural abscess may not show organisms on preliminary culture and a direct smear may only demonstrate

cell debris and the occasional presence of shadowy dead bacteria. The presence of thin pus can also be misleading, for it may be supernatant fluid lying above a thick deposit of pus.

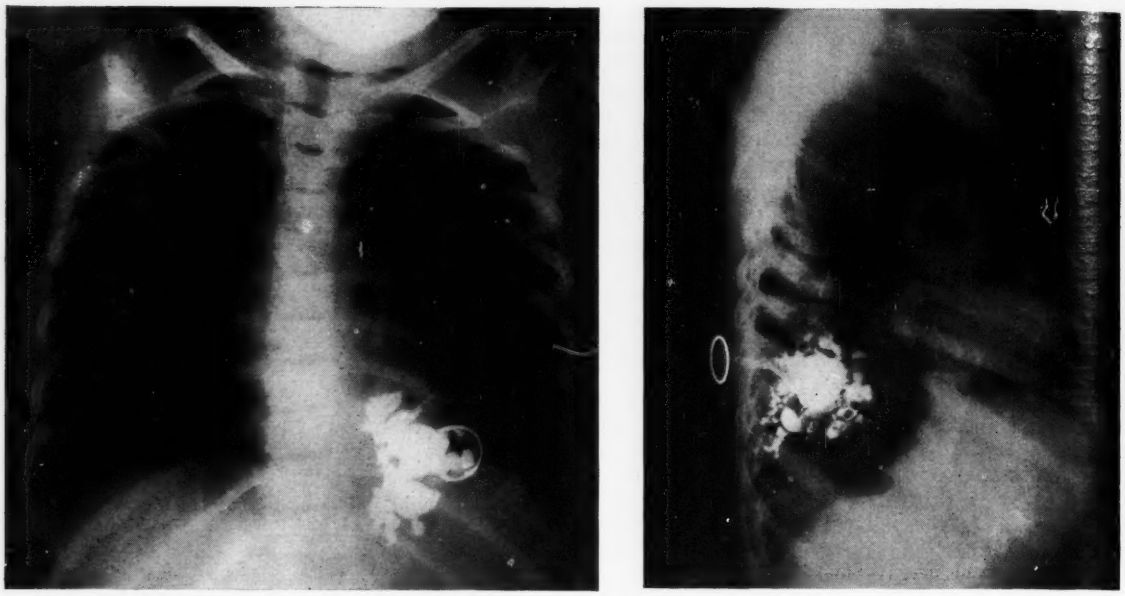


FIG. 601.—Intralobar sequestration. A pocket of pus at the left base has been drained. This was later shown to be contained within lung substance. This lung was in an ectopic lobe supplied by an abnormal pulmonary artery arising from the aorta.

Penicillin-treated empyemata have certain individual features in that early sterilization is obtained in the majority of cases. Fibrin deposit is heavy, possibly as a result of bacteria being eliminated, and with their disappearance fibrinolysins are removed. The average penicillin-treated empyema produces a thick-walled sterile abscess with sterile purulent contents containing fibrin flakes.

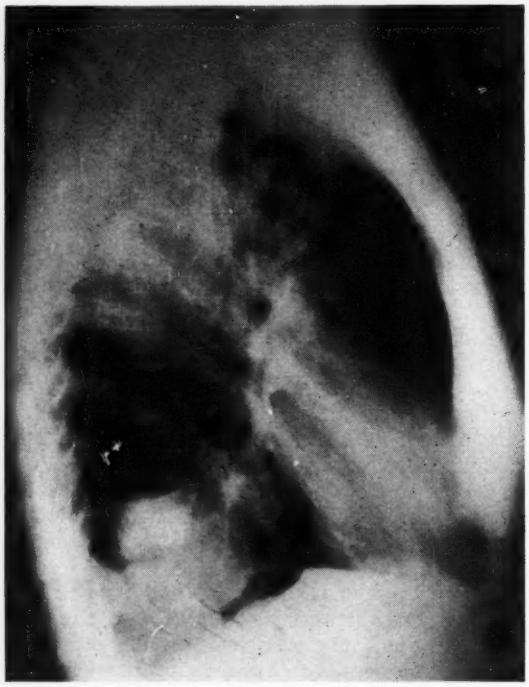


FIG. 602.—Opacity in the left costophrenic angle. Later proved to be an accessory lobe associated with an abnormal pulmonary artery.

Once an empyema has been drained for any length of time secondary contamination of the cavity is inevitable, and the secondary invading organisms, principally *Ps. pyocyanei* and *B. proteus*, are commonly found. These bacteria are so abundant that they act as ' spreaders ' on culture, and may obscure other underlying pyogenic organisms. Selective cultures, as suggested by Professor Knox (1944), are of great value in these circumstances ; phenoxetol to counteract *Ps. pyocyanei*, and dilute sodium azide to eliminate *B. proteus* may reveal bacteria which would otherwise have been overlooked. Phenoxetol has some benefit on local application, but sodium azide is strictly contra-indicated in vivo. Modern antibiotics, however, tend to replace earlier chemicals in the treatment of the local infection. Cross-infection in discharging empyemata is not unusual and the source of contamination has been traced to rolls of adhesive plaster used for holding drainage tubes or dressings in place.

DIFFERENTIAL DIAGNOSIS

(*Figs.* 601–608)

Chronic pleural effusions can be mistaken for a variety of other conditions and the first thing that can readily be decided by the aspirating needle is the difference between clear fluid, blood, or pus. The presence of blood should be considered critically, since it can be obtained from an intercostal vessel or lung, and pus can be aspirated from infected lung tissue as well as from the pleural cavity.

Differentiation between a posterior spherical empyema pocket and a *lung abscess* can be difficult, and indeed the operation of rib resection and drainage may not give the answer unless an extensive biopsy

is taken from the roof of the cavity. A chronic abscess can be so close to the surface that the wall is

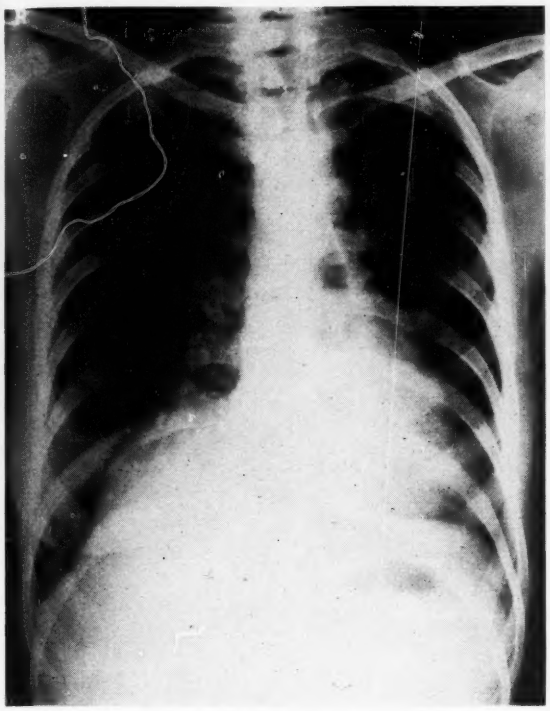


FIG. 603.—Anteriorly placed shadow resembling an encysted collection of fluid, later shown to be herniation of liver.

thinner than that of an empyema. Infected *lung cysts*, sequestration of lung, and *hydatid cysts* can similarly give rise to confusion only resolved by exploration and biopsy. Giant *tuberculous cavities* and breaking-down *new growths* of lung may occasionally present features resembling localized pleural pockets.

Diaphragmatic hernia, specially on the right side, can present as a rounded shadow with a fluid level if a loculus of stomach lies within the thorax. A barium meal should always be carried out if there is any doubt. Herniation of *liver* is an unusual occurrence, but we have encountered 5 examples. Three of these were explored after negative aspiration, and the diagnosis of the remaining two was established by the use of a preliminary pneumoperitoneum. (*Fig.* 605 B.)

A radiological *artefact* produced in the lateral view by overlap of the heart and liver shadows if the right diaphragm is raised has some resemblance in position and shape to an interlobar effusion.

Uniformly opaque tumours of the chest wall are uncommon, but a *fibroma* has on one occasion looked like an encysted axillary effusion. *Chrondroma* and sarcoma have features which should lead to their recognition.

COMPLICATIONS

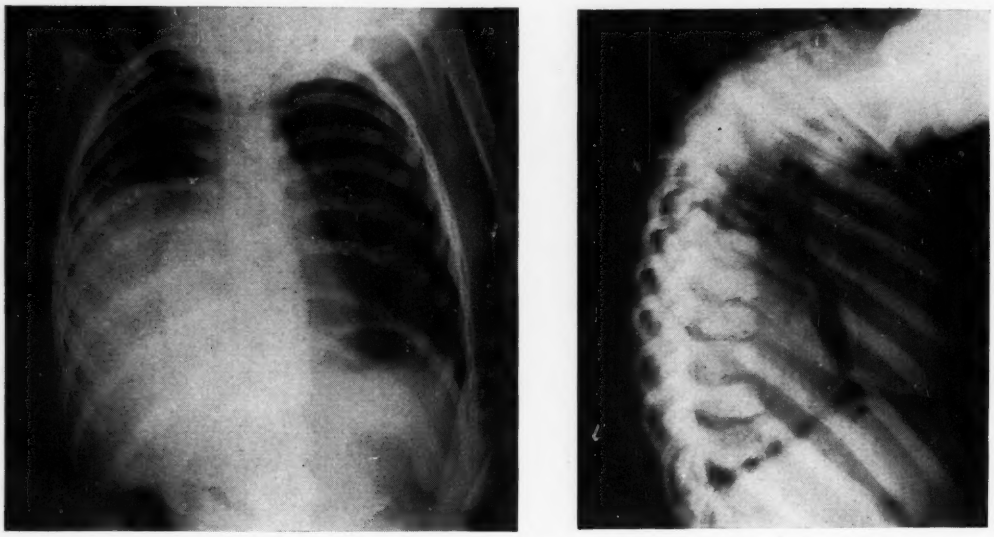
(*Table V*)

The most dreaded complication during the course of empyema treatment is metastatic *cerebral infection*. This can take the form of an acute meningitis or encephalitis, or, if less virulent, will give rise to a cerebral abscess. Until a few years ago these cases were all considered as having a fatal termination.

FIG. 604.—Anteriorly placed shadow resembling an interlobar effusion. This, however, is an *artefact* produced by a high right diaphragm (liver) overlying the heart shadow in the lateral view.

But the original successes in dealing with thoracogenic drain abscesses as recorded by Pennybacker and Sellors (1948), have given new hope. If during the course of treatment there is a persistent headache, dizziness, or any suggestion of cerebral involvement

the advice of the neurosurgeon should be promptly sought, since cure is now within the realm of possibility.



A B

FIG. 605.—Hernia of liver into right chest. Large rounded swelling resembling a posteriorly placed empyema pocket. A pneumoperitoneum was performed and a margin of air appeared around the shadow. B, Shows the posteriorly placed shadow after the introduction of air.

In the present figures 3 patients survived out of a total incidence of 12.

Pulmonary sepsis may continue from an underlying lung lesion or may develop from a fistula or pyæmia. *Bronchopleural fistula* can be divided into two categories: the small and readily healing fistula that results from drainage and is of little significance; and the large or multiple fistula due to some slough of lung tissue through which the contents of an undrained empyema may have been coughed. In this second category there were 41 instances.

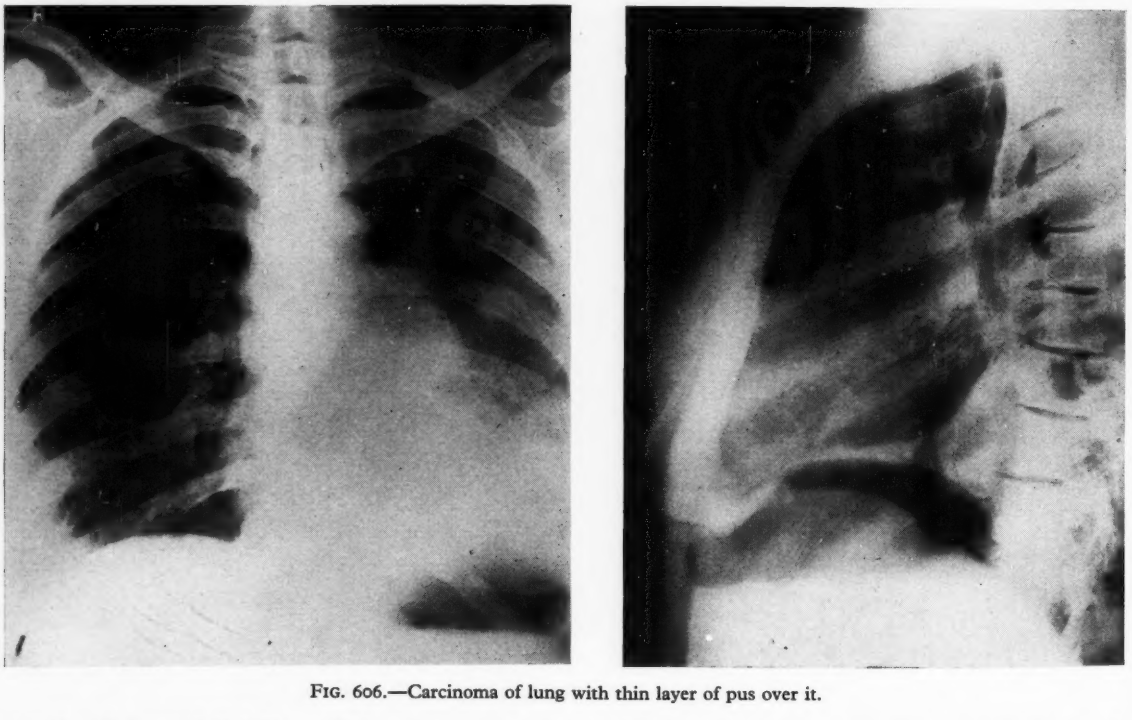


FIG. 606.—Carcinoma of lung with thin layer of pus over it.

as a result of general debility. The occurrence of this complication is not common, though terminal bronchopneumonia is not unexpected and can be regarded under the heading of chronic sepsis or

Hæmorrhage is a dangerous occurrence and has caused 4 deaths in our series. It can arise from ulceration of the tube into an intercostal vessel, or from pressure of the tube against lung or some

internal structure. It can be dramatically sudden and silent in its onset, and though the majority of cases have been arrested by prompt packing, with later

FIG. 607.—Large posterior opacity from which pus was freely aspirated. Proved later to be a breaking-down neoplasm of lung.

securing of the bleeding point, the patients can be found dead in bed with blood steadily dripping on to the floor. The phrase '*drowned*' is another complication which requires the presence of a bronchopleural fistula and the sudden spilling of empyema contents or blood into air-passages. This occurred 3 times, in each instance when the patient

Table V.—CHRONIC EMPYEMA: COMPLICATIONS

Deaths during treatment		45
Cerebral abscess	9	
Pneumonia	6	
Sepsis	6	
Tuberculosis as late development	5	
Hæmorrhage	4	
Drowned	3	
Subphrenic abscess	2	
Heart failure	2	
Tension	2	
Embolism	1	
	40	
Gross bronchopleural fistula		43
Cerebral abscess and meningitis		12
Rupture into pericardium		4
Gross calcification		5
Massive gangrene chest wall		3

was being operated on in the lateral position, with the result that no empyema is now operated on without the patient being upright or in the sitting posture.

Empyema necessitatis can be regarded as a complication in the same way as an empyema coughed up through a pleural fistula. It is an example of the abscess having burst its bounds. With an external extension the pus tends to track along the intercostal spaces and appear subcutaneously at the level of the perforating intercostal vessels. Further examples of rupture can be illustrated with invasion of the pericardium by direct invasion rather than metastasis, and, though œsophageal perforation is recorded, it is probable that perforation was the cause of the

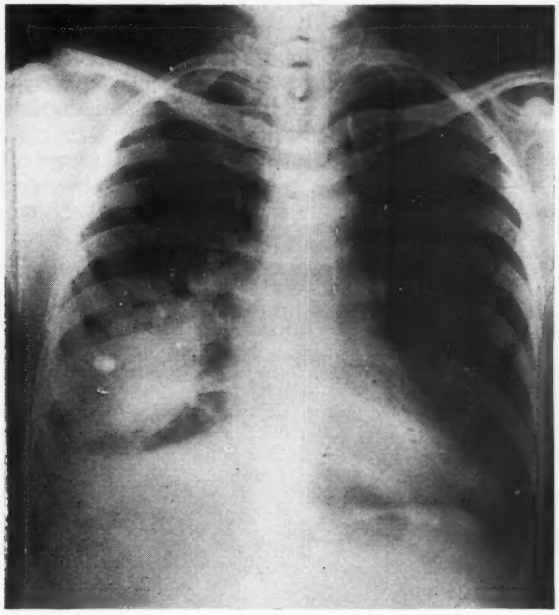


FIG. 608.—Rounded shadow at right base containing pus, later proved to be an infected hydatid cyst.

empyema rather than vice versa. Massive gangrene of the chest wall is a rare but important complication,

FIG. 609.—Massive spreading gangrene of back. Gross involvement of the posterior chest wall following drainage of an empyema.

which in the case illustrated (*Fig.* 609) occurred even with penicillin therapy. It is probably due to anaerobic streptococcal invasion of the tissues, with

a spreading edge which may advance by inches each day. The use of cutting diathermy ¼ in. beyond the spreading margin through the full thickness of skin was dramatically successful in arresting the progress.

CLINICAL FEATURES

It is customary to divide the clinical picture of chronic empyema into general and local aspects, the former being concerned with toxæmia and the latter with the actual chest condition.

In the majority of cases there is a story of a previous pulmonary or pleural infection, but occasionally with an undiagnosed abscess a careful history will have to be taken to elucidate some illness in which the condition originated. Again, unexpected recrudescence may occur months or even years after the empyema has apparently, but not actually, healed.

The effect of an enclosed pocket of pus is not always as great as might be thought. Some patients do not show obvious signs of toxæmia, such as fever, lassitude, and wasting, and only realize that they have felt ill after the pus has been drained, and they then notice the improvement. Leucocytosis is usually present, but in really long-standing infections leucopenia may occur. Anæmia is constant and may be progressive and severe. This feature has been examined by the authors, who had the bone-marrow of resected portions of rib examined histologically; the conclusion was that the marrow showed signs of chronic toxæmia with active destruction of the blood-forming elements.

General debility and chronic depression is a very real feature and psychiatric advice is sometimes sought if the actual physical state is not treated. Even if a chronic empyema is drained the persistent discharging sinus is a definite disability with its necessity for daily dressings.

A classification of empyemata into closed, intermittently discharging, and permanently open, can be used in connexion with the symptomatology, which varies according to the severity of the infection and its outlet. Associated with prolonged infection are such occasional features as clubbing of the fingers, cardiac disability, cyanosis as well as dyspnœa, and limited exercise tolerance. Amyloid disease is also found in some examples of chronic empyema, but almost always when a tuberculous or actinomycotic element is present. It may be noted that syphilis of the pleura is almost unknown.

The actual chest condition depends on the extent and duration of the empyema. Restriction of movement, flattening of the chest wall, traction of the mediastinum, and spinal deformity may be present, and the local signs are those of dullness and loss of air entry. In children the easier conduction of breath-sounds makes it difficult to distinguish chronic pleural infection from collapse of lung. If there has been drainage and a sinus or deep puckered scar is present, any recrudescent abscess will point in this region even though the main pocket of pus is at some distance from the scar.

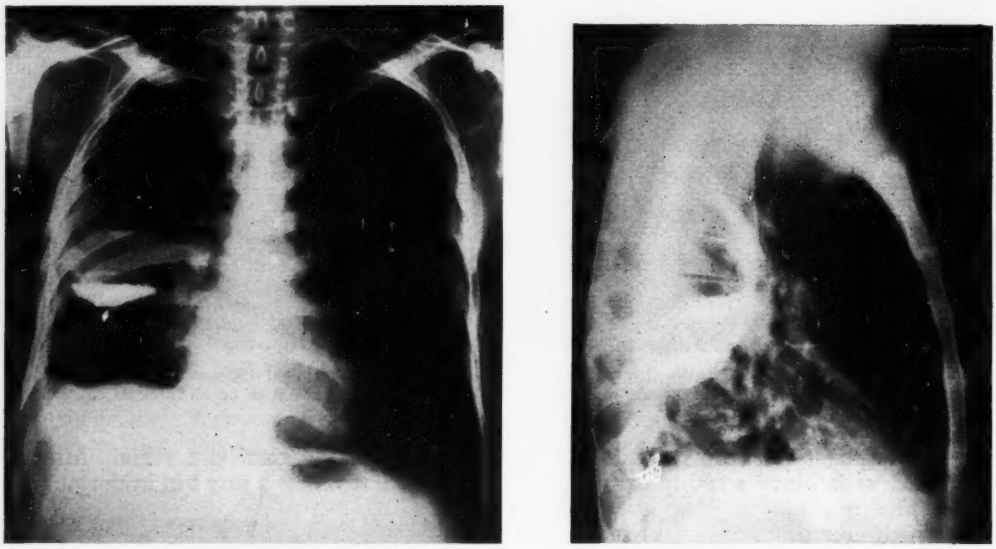


FIG. 610.—Introduction of lipiodol into encysted empyema on the right. The opaque oil shows the lowest point of the cavity and above this is the fluid level of pus and air.

If a drainage-tube has been abandoned for some time the sinus will be of the 'pin-hole' or narrow variety, through which a variable amount of discharge emerges. A stale or offensive odour suggests retention of pus, and a 'pin-hole' sinus frequently closes down for a time only to re-open if the contained infection becomes active again. The length of the sinus as gauged by the passage of a probe is considerable, and the walls are rigid and fibrotic, explaining the occlusion of the drainage opening.

INVESTIGATION

After a complete clinical survey with radiological examination in two planes the actual empyema cavity should be studied. If there is any external opening the bacteriology of the pus can be studied and radio-opaque oil injected through the sinus into the cavity. Should, however, the opening be too small to admit a fine catheter, it must be dilated. This is achieved by using a laminaria or sea-tangle tent which swells and dilates the opening within 24 to 48 hours,

repeated if necessary to ensure a reasonable opening. The main obstruction is at the level of the ribs, where bone regeneration may have produced a narrow and completely rigid ring. Forcible dilatation with bougies is contra-indicated, since cerebral air or pus embolism has been recorded as a result of this procedure.

Once oil can be injected a two-plane radiograph can be obtained to give some idea of the extent and shape of the interior of the empyema (*Fig.* 610). At the same time a few millilitres of methylene blue solution can be injected to see if it will be coughed through a bronchopleural fistula.

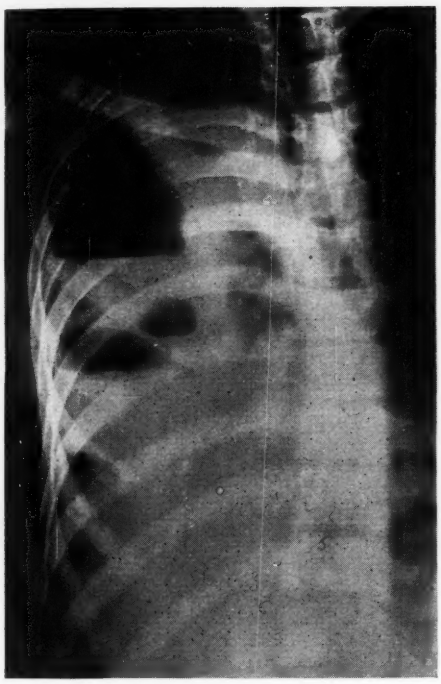


FIG. 611.—Multiloculated empyema on the right side. Treated by simple drainage.

In a closed empyema the pocket should be aspirated as a preliminary to contrast radiography and the information gained gives considerable help in deciding the site for dependent drainage.

No full investigation is complete without *pleural biopsy*, which frequently reveals such unexpected features as tuberculosis, actinomycosis, or neoplasm, but this biopsy can only be taken during formal pleural drainage with rib resection.

Bronchoscopy should be employed in every case where the cause of the empyema is not absolutely clear. Foreign bodies and growths have been often discovered in this way and, if there is any productive cough, bronchography may show bronchiectatic changes which would account for the persistence of the infection.

TREATMENT

(*Table VI*)

The principles of treatment are three :—

1. Elimination of toxic contents.
2. Closure of the cavity.
3. Restoration of lung function.

In most instances some attempt will have been made by drainage or chemotherapy to eliminate the infection, but the obliteration of the dead space and reduction of lung function are the neglected factors.

Prophylaxis by correct handling of the acute phase is the obvious basis for treatment and this can be best expressed by continued and adequate drainage coupled with intensive physiotherapy. A motley variety of drainage and irrigation methods has been advocated from time to time, but these cannot replace the more simple and effective principles just laid down. A chronic empyema once diagnosed must be correctly drained (*Figs.* 611, 612), and this drainage constantly supervised until complete healing has occurred, and with this surgical treatment vigorous physiotherapy perseveringly pursued. On occasions it is justifiable to consider complete excision of the empyema (pleurectomy) with its walls and contents, and so remove a harmful dead space, leaving the lung free from constricting scar tissue. This operation is, however, a major one and requires all the services of a fully equipped thoracic surgical unit.

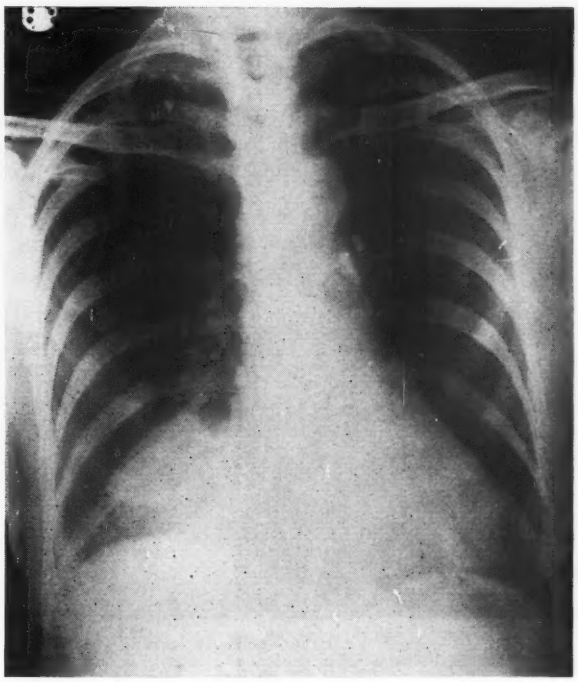


FIG. 612.—Encysted empyema at right base. This followed an upper abdominal operation and was treated by drainage.

Table VI.—CHRONIC EMPYEMA : TREATMENT
(622 *Non-tuberculous Cases*)

No treatment. Too old, refused, or N.G.	9
Continued treatment	63
Aspiration only	32
Closed drainage	11
Re-drainage	394
Pleurotomy only	13
Decortication or pleurectomy	25
'Saucerization'	37
Schede or Roberts' type	10
Muscle grafting	17
Paravertebral thoracoplasty (7 of these followed loss of lung substance)	11

Respiratory physiotherapy deserves special mention since it is only carried out with full effect in chest units. The requisite exercises aim at localized and forceful inspiratory efforts with the patient concentrating on moving the area of the empyema. Persistence and encouragement will result in the expansion of an immobile section of chest wall. The lung will follow this movement and help to obliterate the empyema cavity. These objects are easily achieved, and daily, even hourly, practice is essential. Ten to twenty minutes' exercises every waking hour produce results that cannot be obtained in any other way. In an extensive, rigid, chronic empyema a period of months may be required, and in one case success was only reached after a year and a half.

FIG. 613.—Position of patient and surgeon in the operation of empyema drainage. The patient sits on the diathermy pad and is balanced by the spread-out arms across the operating table. There is no risk of pus or blood entering the bronchi.

The traditional measures of blowing up balloons and the like can be discarded, as they are expiratory in character and not inspiratory. Full postural and general exercises should also be used and the problem is simplified if the patients can be ambulatory for the greater part of the day and can take active physical exercise. For this reason the ordinary conditions pertaining to a general hospital are not ideal for the treatment of chronic empyemata.

Economic and social factors have a bearing on treatment since it is not feasible to hold all patients in hospital for the full duration of their treatment. Out-patient clinics to deal with regular contrast radiography and tube control are established in most chest centres and the progress of the healing carefully watched.

Not only must the local condition of the patient be considered, but there must be a regular examination of the general condition, and in particular the blood-count, for chronic anæmia is a common association and may even require transfusion. Many patients are seriously worried by the nature of their condition, but if they can be assured that the malady is neither tuberculous nor malignant, that it is simply a chronic infected cavity that has to be treated, many of their hidden worries may be alleviated. As has been said, early movement and exercise by patients is most important, and above all the average ward life with patients shuffling around in bedroom slippers and dressing gowns must be avoided. As soon as a patient is allowed out of bed and this should be possible from the outset, he should be fully dressed and encouraged to take full and active interest in his surroundings. If a long-term stay in hospital is prospected the patient must be encouraged to find

FIG. 614.—Note small dressing held in place with an Elastoplast corset.

some form of activities that will prevent him from becoming the 'mental chronic', and even if he is living at home and attending as an out-patient there is no reason to stop him in engaging in quite active physical work. The full appreciation of psychological aspects is not least of the responsibilities of the surgeon in charge of the case.

LOCAL TREATMENT

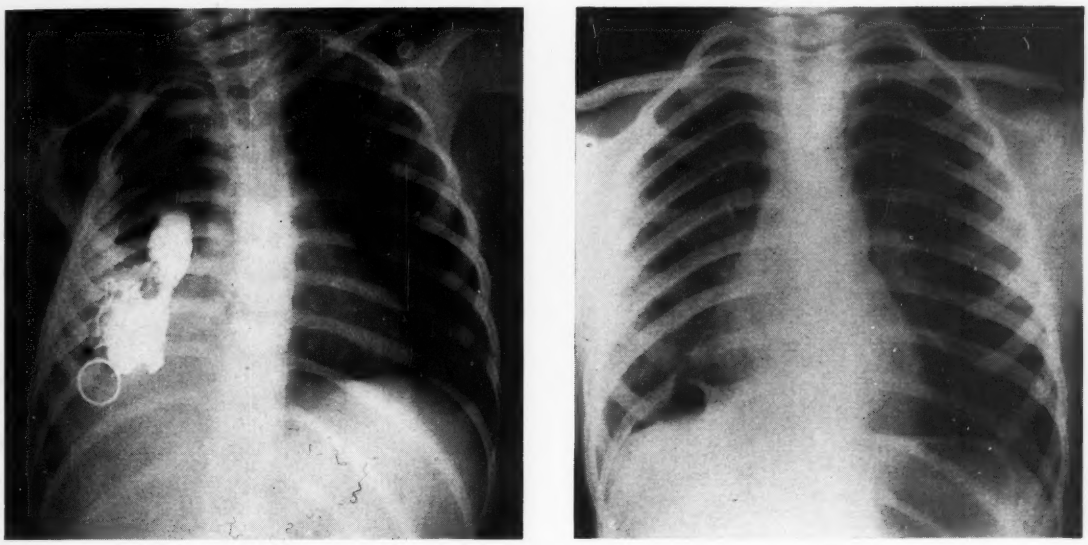
A bewildering variety of operations for chronic empyema have been described; many of these involve multiple rib resections and result in deformity. The operations as originally described by Estlander and Schede should never be necessary with modern and simple methods. They are usually performed in an endeavour to secure rapid healing, but it must be stressed that chest units are prepared to wait for a year or even eighteen months in some cases, so long as progress is being achieved. It is

the failure to see early and rapid cure that mistakenly may lead to mutilating surgery, and whereas time lost by prolonged treatment is admittedly a disadvantage, the misguided attempt to curtail the illness is more harmful, as it must inevitably lead to loss of function. In the present series it will be noted that major surgery was only undertaken on 54 occasions, and the material had often passed through other hands over months or years before it was taken over.

Adequate Drainage.—After investigation the most simple and satisfactory form of treatment is based on *re-drainage*. This is usually a deliberate measure in which the scar and thickened pleura is adequately excised so as to allow inspection of the cavity and subsequent insertion of a drainage tube at least 1 in. in internal diameter. In other words, this re-drainage is a minor thoracotomy involving incision of scar and removal of regenerated bone. Usually one rib, or what is left of it, is excised, but excision of 2–3 in. of an adjacent rib is sometimes advisable.

The patient is operated on in a sitting position (*Fig.* 613) with local anæsthesia and a light intravenous or inhalation anæsthetic. The original scar or sinus is excised with diathermy and the wound deepened down to bone, which is then removed—occasionally a matter of some difficulty. If an intercostal vessel is visible it should be secured, at the same time avoiding injury to the intercostal nerve. Then the full thickness of the parietal pleura is removed with diathermy and sent for microscopical investigation. The interior of the cavity is sucked dry and inspected with a malleable light to ensure that no foreign substance is overlooked. The movement of the deep aspect of the cavity (the visceral pleura covering lung) should be observed, for if this moves at all on respiration early healing can be anticipated, but if the lung is rigidly held there is little chance of speedy closure.

The drainage-tube selected should be of wide diameter, and is secured after making certain that its position in the empyema cavity is correctly adjusted. In other words, it is placed so as to lie with its internal opening just inside the cavity, not projecting therein or impingeing against the lung. Fixation of the tube is achieved by a safety-pin and thin strips of strapping applied to the chest wall, and the tube is cut flush and retained with the safety-pin. A light dressing held in place by a corset (*Fig.* 614) completes the operation. These details, though elementary, are stated here since it is clear that they are not recognized in many hospitals, where projecting ends of tubes are not held secure, and many-tailed bandages, imperfectly holding soiled dressings, present a miserable picture of discomfort.



A B

FIG. 615.—Penicillin-treated empyema in a child. A, Position immediately after drainage, illustrating size of cavity and thickness of empyema wall. Note the scoliosis. B, End-result, showing complete expansion of lung under simple drainage and absence of scoliosis. Note periosteal ring which has formed around the drainage-tube.

The correct relationship of the drainage-tube to the interior of the empyema cavity is controlled by making any necessary adjustment after pleurograms have been obtained. These are performed every two, three, or four weeks, according to the rate of healing, until the drained cavity is only represented by a tube track. To summarize the teaching of the late J. E. H. Roberts : a tube is never removed from an empyema cavity, it is only removed from a track in the chest wall.

The tube may have to be maintained for months, but there is no cause to change the policy of adequate drainage so long as the dead space shows a progressive reduction in size (*Fig.* 615). We estimate that over three-quarters of our patients have healed in this way, aided by vigorous physiotherapy. The time factor was in the region of two to three months, but there were longer periods for old-standing cases with very rigid walls. Only if the cavity remains static over a period of some weeks need additional surgical measures be considered.

Skin-flap Drainage (*Figs.* 616, 617).—The use of a skin-flap turned inwards is useful in ensuring continued drainage in cases in which the control of

a tube may be difficult or where there is likely to be permanent drainage, as in cases of empyema due to a malignant condition or extensive calcification. The aim of the skin-flap is to provide an epithelialized

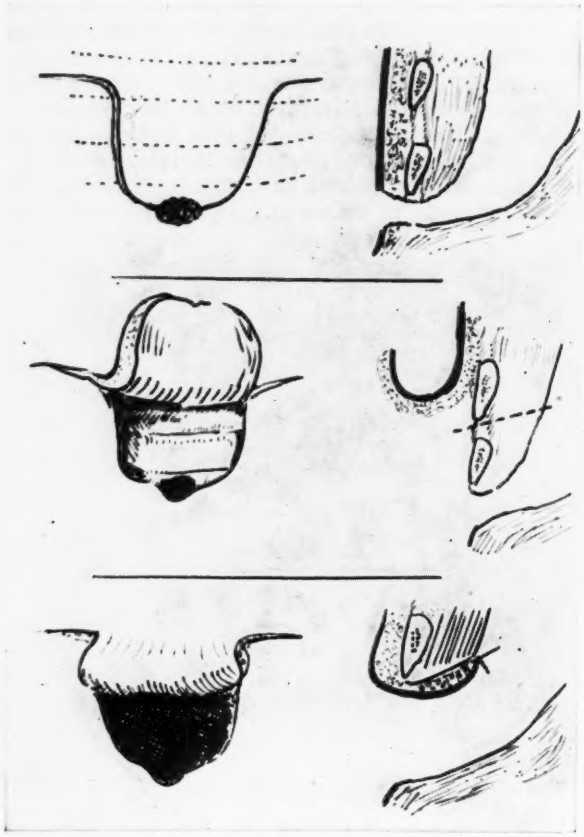


FIG. 616.—Skin-flap operation illustrating principles by which an epithelialized track can be formed.

lining to the track so that it does not cicatrize and will remain open.

The technique is to cut a 'U'-shaped flap of skin with the tongue downwards and, having incised muscle, to excise two or even three lengths of rib and then to cut away the full thickness of the pleura so that a wide opening, about 1½ in. to 2 in. in diameter, is obtained. The skin-flap is then turned in and sutured to the upper margin of the cut parietal pleura and held in place by a firm packing of vaseline gauze. The packing is pressed firmly against the upper margin until it becomes adherent; after this the opening has only to be covered by a dressing. The only possible disadvantage of the method is that if the empyema is situated low down the division of more than one intercostal nerve may be necessary.

Unroofing, Guttering, or 'Saucerization' (*Figs.* 618, 619).—In deep-seated and chronic cases where the pleura is unduly thick, healing can be very slow, and this tardiness is most noticeable in the terminal stages of healing. As a result a long narrow track or a small deep pocket persists, and remains stationary in size. Here it is possible to remove the full thickness of chest wall and pleura over the cavity so as to leave it in the form of a wide saucer or gutter which granulates up from below. The area of skin and chest wall to be removed has to be more extensive than might be expected, but as in the case with rectal fistula operations, healing by granulation is much more rapid on the surface than in the depths. In such a case not more than 3–4 in.

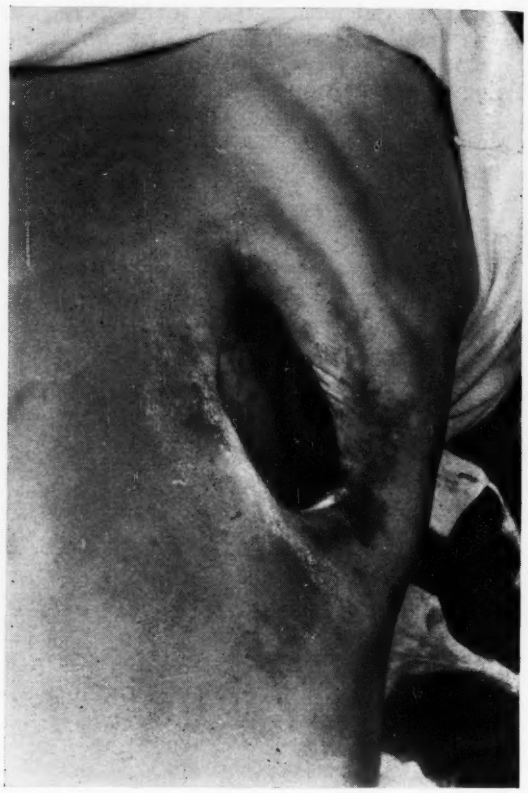


FIG. 617.—Skin-flap drainage used in the case of an elderly man who lived a long way from hospital. The large epithelialized track ensures perfect drainage. This has an unusually large opening.

of three ribs would have to be removed, but if the track is long and thin the number of ribs removed may have to be increased. The terminal scar in these cases is much less than one might expect, and the deformity is negligible in contradistinction to the more elaborate thoracoplastic operations which will be described later.

Graft Filling.—The filling of the residual cavity by muscle graft is frequently quoted as a suitable procedure, but it depends largely on the amount of muscle available and the size of the cavity. Pedicled muscle is the only reasonable graft tissue to employ; our experiments with free fat and other tissue grafts have been unsatisfactory. The difficulty in obtaining enough muscle depends to some extent on the fact that the incision for original drainage or re-drainage will have cut across part of the muscle sheets which it is hoped to employ. The latissimus dorsi is the obvious choice for a posterior empyema but has rarely enough bulk or length to be of value. Anteriorly the pectoral muscle and breast are possible filling agents, but chronic pockets in this area are rare and the deformity following their use may be considerable. The most valuable muscle graft comes from the intercostal bundles, which, though small in

size, are well placed and can be turned down quite readily into a small deep track or pocket.

In no circumstance should a muscle graft be used until the bacteriological survey of the cavity suggests that it is 'clean', and when a graft is applied it should be stitched down carefully with its nerve and muscle supply intact, a large amount of penicillin placed around it, and the wound completely sutured without drainage and covered with a firm and local pack.

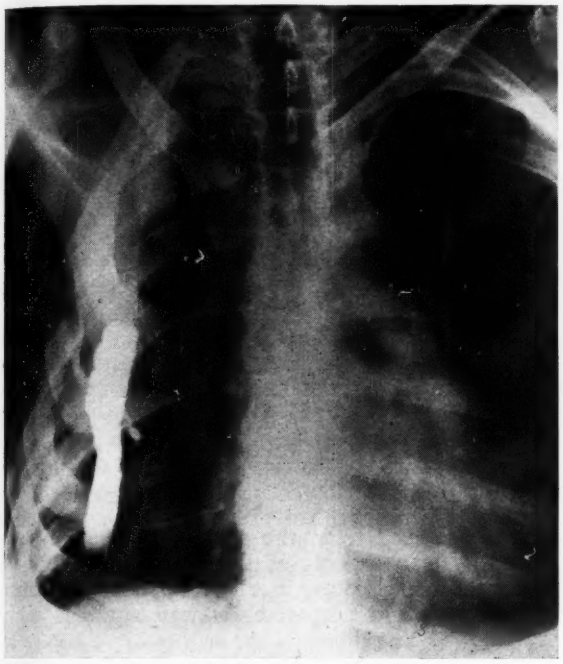


FIG. 618.—Chronic right-sided empyema showing gross flattening of the right chest but with little deformity. Pleurogram gives some idea of the thickening of the parietal pleura. Treated by guttering operation. (*See Fig.* 619.)

Our comment on this form of operation may be expressed by the fact that it was only used in the series on 17 cases out of 622.

Pleuroplastic Operations. — Though the Schede type of operation has almost been abandoned, simplified operations on the same principle have had a certain degree of popularity. In the Schede operation the rib, intercostal muscle, and pleura over the cavity are completely excised after the manner of an unroofing or saucerization operation; then the skin and superficial muscle are pressed down against lung. It was designed for large axillary cavities and is both a massive and mutilating operation. Allison (1943) has suggested a freeing of the parietal pleura from the deep surface of the ribs and pressing this layer down on to the deep aspect of the empyema cavity. This left a dead space between the deep surface of the ribs and outer aspect of parietal pleura which was lightly packed and being a fresh wound tended to heal up by granulation. Roberts designed an operation in which rib was removed over the cavity and then the cavity opened by incising the parietal pleura over its anterior edge. The cavity was cleaned out and pockets removed, and having hinged or cut the parietal flap so that it would lie well in and against the lung, the wound was closed. Preservation of the blood-supply from behind was felt to be necessary, though in many instances if the hinge is placed anteriorly a more satisfactory placing of the flap could be obtained.

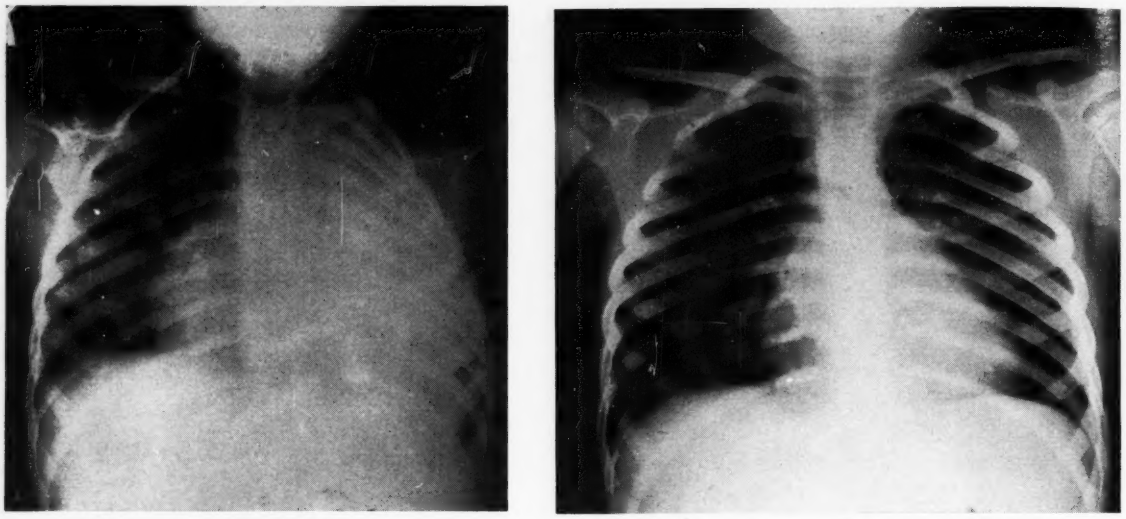
These operations are all based on the principle of removing or mobilizing the parietal aspect of the cavity to obtain closure, and if a cavity is large they have to be performed in stages since operation shock is often severe. They hardly appear to be necessary in the instance of a small cavity where the principle can be elaborated by converting the operation into the gutter or saucer type. Again the comment is that this operation has been used only 8 times in our series.

FIG. 619.—End-result of a 'guttering' or 'saucer' operation, showing comparatively small deformity.

Thoracoplasty.—The operations described under the heading of pleuroplastic procedures involve a good deal of rib removal, but are distinct from deliberate extrapleural thoracoplasty as used in the treatment of tuberculosis or tuberculous empyema. Thoracoplasty avoids any entering of the empyema cavity, and by reducing the size of the parietes crumples the cavity and so helps its closure.

It is an operation only to be used when the more simple measures have shown their complete failure and when the cavity is an extensive one stretching up towards the apex. There is no other way in which the size of the hemithorax can be so effectively reduced without gross deformity, but it is unfortunately an operation too readily adopted in chronic empyema because of its success in the field of pulmonary tuberculosis. In our opinion it is of value if the empyema has been associated with gross loss of lung substance, but has little place in ordinary chronic empyema. In other words, in cases where there has been a massive slough of lung with a subsequent empyema, the lung may not readily fill out

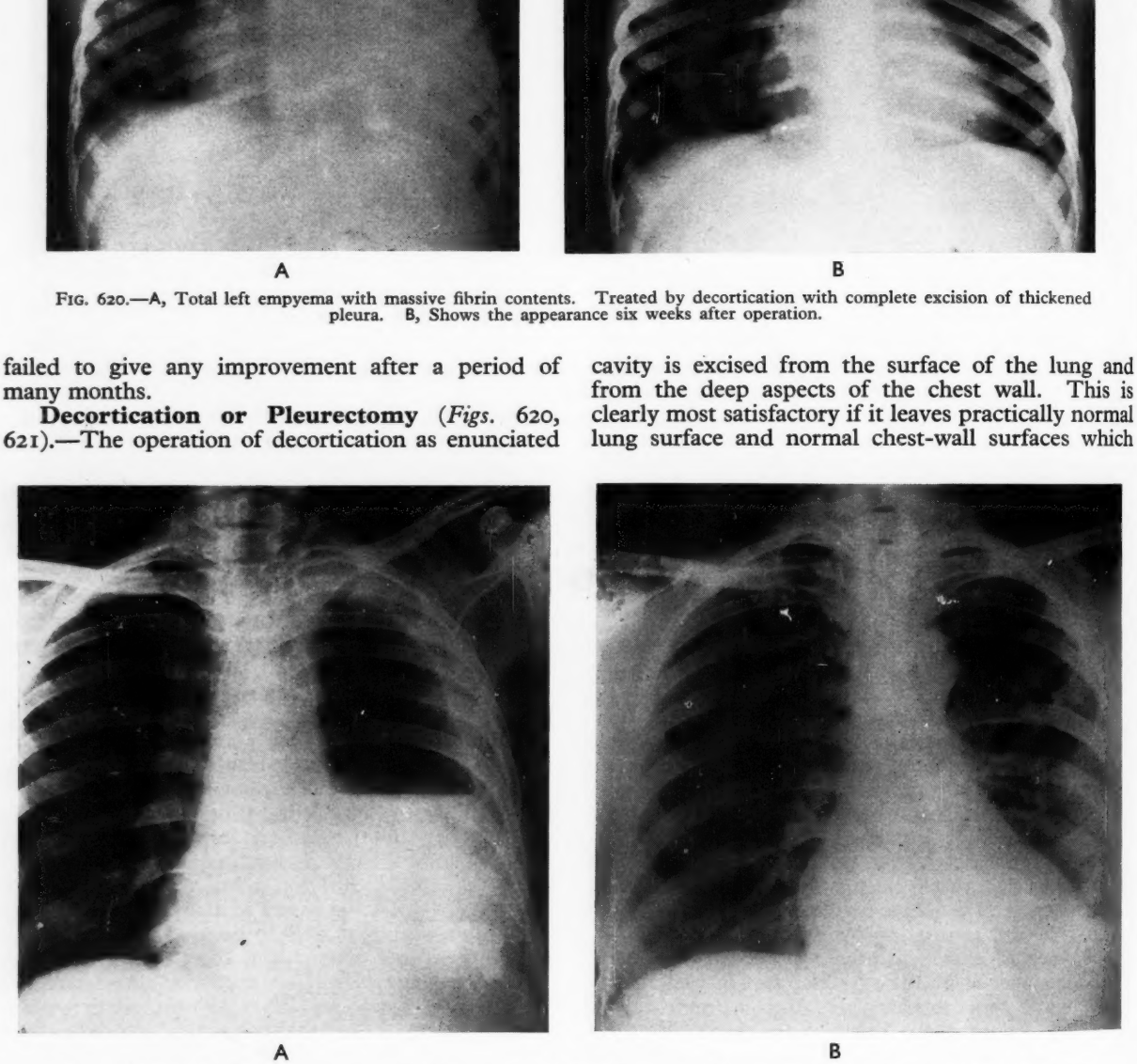
and occupy the hemithorax. Here an upper 6- or 7-rib thoracoplasty is of value and was used in 7 instances in our series. The remaining 4 thoracoplasties were only undertaken when ordinary methods failed to give any improvement after a period of many months.



A B

FIG. 620.—A, Total left empyema with massive fibrin contents. Treated by decortication with complete excision of thickened pleura. B, Shows the appearance six weeks after operation.

Decortication or Pleurectomy (*Figs.* 620, 621).—The operation of decortication as enunciated by Delorme has been intermittently used in chronic empyema over many years, but in the absence of present-day technique and chemotherapy the operation was little used until it was found to be of value in clotted hæmofibrothoraces in the last war. The simple freeing of lung was elaborated to include the parietal pleura, and the present view is that decortication should take the form of an excision of pleura in such a way that the whole empyema cavity is excised from the surface of the lung and from the deep aspects of the chest wall. This is clearly most satisfactory if it leaves practically normal lung surface and normal chest-wall surfaces which can be made to approximate. It is undoubtedly going to play a considerable part in the future treatment of chronic empyema, but it is a major operation and should not be used to cover defects in ordinary treatment. Where there is inadequate



A B

FIG. 621.—Total left-sided empyema sterilized by early penicillin therapy. A, Lung completely collapsed. Lipiodol in base of cavity. Treated by decortication and pleurectomy. B, The position two months after operation.

physiotherapy there is the likelihood that pleurectomy will flourish.

The timing of the operation is difficult. It should certainly not be considered within six to eight weeks from the onset of the empyema, and it may even be considered in cases in which the duration has extended to a year or more. Successful decortication has been carried out after an interval of ten years. The eminently suitable case is in a child with a penicillin-treated empyema where the fibrin thickening has been rapid and where the lung shows a marked reluctance to expand. From the technical aspect it is wiser to embark on an extensive operation rather than a too limited one. A long posterolateral incision such as is used in a thoracotomy is made, and the parietal pleura is eased off the deep surface of the ribs before any rib retraction can be made. The dissection of parietal pleura is continued until the edges of the empyema cavity are found and non-adherent lung is exposed. The dissection is then carried over the lung, peeling off the visceral pleura like a stiff rind from a fruit until the whole empyema is free. Originally the cavity was deliberately opened and the visceral layer peeled off, leaving the decision as to the removal of the parietal pleura until this had been done, but if the pleural adherence is not too marked and there is not too much shock or bleeding the removal of the empyema sac *en bloc* is much more satisfactory. Small tears in the lung surface are not uncommon and the difficulties of the actual decortication should not be underestimated. The exposure and removal of pleura from the diaphragm can be very difficult, but once the lung surface is free, then with the help of the anæsthetist the lung can be inflated against the chest wall.

The use of chemotherapy, both local and general, is necessary to avoid re-infection, and the chest should be drained by a closed or even suction system using one or even two tubes. The freed lung must be held out against the chest wall and any air escaping from small tears in the lung surface removed by the suction drainage which is continued for several days until the danger of a chronic pneumothorax or re-infection has passed.

In a satisfactory case the re-expansion and complete obliteration of the pleural space is effected rapidly, and the patient may be ready to leave hospital in two to three weeks. This is a dramatic economy paid for with the price of a major thoracotomy, but the re-expansion of lung is not always perfect and a residual pleural pocket requiring repeated aspiration or drainage results. Sometimes there is a recrudescence of infection, which has to be treated by chemotherapy and, later, drainage, but the size of the space is invariably much smaller than the original chronic empyema.

The value of pleurectomy lies in the time saved and in the avoidance of prolonged tube drainage, which latter is important in children. Against these advantages must be weighed a major operation which cannot always be technically successful, and some risk of an imperfect result. We feel that the operation should be reserved for cases in which simple drainage is not likely to produce a speedy result owing to the thickness of the fibrin deposit. Sterile empyema pockets following penicillin therapy in children are the best indication.

Miscellaneous Methods.—There are various aspects of treatment popular from time to time which demand comment. Continuous suction drainage using a Roberts suction motor has theoretical advantages in encouraging the obliteration of the cavity, but the suction is difficult to maintain in the presence of a wide tube owing to air leaks around the tube or bronchial fistula. We feel that it should only be used at night with patients in bed, and to clip off the tube during the day so as not to restrict activity and movement.

Irrigation is from time to time recommended, and the literature is saturated with references as to the value of certain solutions. Most of these have aimed at dissolving the fibrin, and whereas Dakin's solution and gentian violet have their advocates, the most effective solvent would appear to be the pepsin-acid solution of Herrmansdorfer. All irrigation is dangerous in the presence of a fistula, and in Stephen Paget's earlier accounts of treatment the number of deaths consequent on irrigation was alarming; nor are the risks absent at the present time if a fistula is not recognized, and the irrigating solution can flood the lung. Local chemotherapy has some benefit, and numerous vehicles for carrying penicillin so as to leave it adherent to the cavity walls have been tried, but again their success has been limited. The packing of a very small residual cavity with fibrin foam after ensuring that it is clean has solved the difficulties of a terminal pocket in many of our cases.

The presence of a *bronchial fistula* at some time or other during the process of healing in an ordinary empyema is extremely common, but it is rarely large enough to cause much inconvenience. These small openings are often only detected when pleurograms are being done, when a small trickle of oil is seen to enter the bronchi and produce a partial retrograde bronchogram. These fistulæ may not give rise to blowing, and tend to heal without interference. They are usually caused by pressure of the drainage tube against the thickened visceral pleura, with ulceration into lung tissue. Large bronchial fistulæ are more persistent and obvious. They cause blowing and a variety of odd noises and are usually accompanied by a discharge which is mucoid, this being characteristic of communciation with a mucous epithelial surface. In the present series gross bronchial fistulæ have been defined as cases in which the empyema has been coughed up, or in which the opening delays the normal progress of healing and becomes a serious complication. Such a fistula may be present if a lung abscess, unrecognized tuberculosis, or a growth is associated, and in these cases healing is difficult. Apart from these unexpected factors, healing, even of multiple fistulæ, usually takes place.

Many and varied operations have been designed for the treatment of bronchial fistula, but they are mostly obsolete or unnecessary. If complicating factors, as tuberculosis and growth, are excluded, the majority of fistulæ heal during the course of continued and adequate drainage, but an occasional persistent fistula may require attention.

In this case the empyema cavity is freely opened and the opening into lung identified. The essentials of closure are the destruction of the bronchial mucosa by formal application or cautery and freeing of

adjacent tissues so that the fine sutures used for the actual closure are not under tension. Care has to be taken to avoid bleeding which might enter the bronchial tree, and the sutures can be covered with advantage by an intercostal muscle graft. This fistula closure may be part of a more extensive decortication or pleurectomy which would not be successful if the opening were allowed to persist.

Our experience in dealing with chronic empyema has shown that the best treatment is simple and uncomplicated. Continued patient and adequate drainage coupled with vigorous physiotherapy is the basis. Many mutilating operations have been used in an endeavour to shorten the convalescent period; all are destructive of some lung function which might otherwise have been restored. No study of chronic pleural infection can be made without realizing how badly the acute stages have been handled, and even at the present time, with the potent aid of chemotherapy, we must be fully alive to the fact that it *is* an aid, and not of itself a cure.

Our particular thanks are due to Dr. G. R. Osborn, of the Department of Pathology, Derbyshire Royal Infirmary, for his helpful advice on the pathological aspects of this problem and for the loan of the photomicrographs of the pleural biopsies.

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LIGATION OF THE AORTA AND THE USE OF CELLOPHANE FOR ABDOMINAL ANEURYSM

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ANEURYSM of the abdominal aorta has long been regarded as a comparatively fatal condition for which little can be done. While it is hoped to show that surgery can help in certain cases, it is not suggested that this, or any other foreseeable advance in treatment, will greatly alter the prognosis, by and large, of the disease. The majority of patients die within two years of the onset of symptoms, rupture of the aneurysm being the common cause of death. Over half of the 65 cases reported by Kampmeier (1936) died within a month of admission to hospital, but of these a high proportion were syphilitic aneurysms, which have a worse prognosis than atheromatous aneurysms. Colt (1927) found the average duration of life in saccular aneurysms of the abdominal aorta to be about a year from the appearance of symptoms.

Although treatment has not generally been considered a surgical problem, it is one which has interested surgeons for a long time. A century ago the aorta had already been ligated on four occasions and, including the cases herein, there are now 51 recorded instances of this operation on 46 patients. Three patients each had 2 ligations on separate occasions and another had 3 successive ligations in the course of a staged occlusion. The application of an encircling cellophane band to the abdominal aorta is counted as a ligation. In 42 of the patients the operations were for aneurysm of the abdominal aorta or the vessels immediately distal. Success has not often been achieved, but fortunately this has not deterred surgeons from recording their experience, as something can be learned from the failures, of which the personal case here presented is one. It has also been thought worth while to review the subject generally, with particular reference to the more recent case reports. Abstracts of these have been made and are presented as a numbered series to which, for convenience, reference will be made, rather than to the author on every occasion.

SURGICAL TREATMENT

The ideal operation for aneurysm of a major vessel—namely, aneurysmorraphy with restoration of the arterial lumen—is hardly ever applicable to the aorta. It requires a saccular aneurysm and a healthy arterial wall, whereas aortic aneurysms are usually fusiform and nearly always occur in a vessel severely affected by atheroma or syphilis. Bigger's (1940) case of traumatic aneurysm (*Case* 11) is a brilliant exception. Excision of the aneurysm and, alternatively, aneurysmorraphy with obliteration of the arterial lumen, are theoretically the next most desirable procedures. The few attempts at either have been completely unsuccessful, but Monahan (1944) (*Case* 15) succeeded in isolating the aneurysm by complete occlusion above and below. Except for *Case* 2, in which ligation was distal to the aneurysm, all ligatures and bands have been applied proximally, with the object of slowing the arterial stream enough to allow natural cure of the aneurysm by clotting. The operations in this group can be divided into those designed for immediate occlusion of the aorta, either complete or partial, and those aiming at delayed occlusion, either in stages or by gradual compression. Gradual compression by mechanical means, part of the device being brought out externally to permit periodic adjustment, has failed owing to infection along the track of the instrument. Gradual compression by physiological means, encircling the aorta with a band of material sufficiently irritating to the tissues to cause a constricting fibrosis, has been tried with some success. The use of cellophane for this purpose will be discussed in a later section.

The methods of producing occlusion so far considered have aimed at doing this from outside the

aorta, though the hope has existed that the external pressure might provoke the intima to react and become permanently adherent. The alternative approach has been from within the artery or the aneurysm. Occlusion by the insertion of a fascial plug into the aorta has been tried (*Case* 8). The introduction of wire into the aneurysm and into the aorta, with or without the passage of an electric current, has been practised intermittently and has repeatedly brought about considerable clotting, but the results have been so uncertain and the risks so great that the method has fallen into disuse. Reid (1926) recorded 8 cases treated at the Johns Hopkins Hospital, with only 1 good result. An improved method of wiring and endothermic coagulation has recently been described by Blakemore (1947), and it is possible that this method of treatment may repay further study for use in conjunction with occlusion from without.

The development of the surgery of abdominal aortic aneurysm falls rather naturally into two periods, before and after 1918, by reason of the results achieved. In the earlier period there were 22 ligations in 21 patients, all of whom died within a few days or, exceptionally, weeks. In the later period, although the results were still not good, half the patients survived six months and several over a year, in a few cases with great improvement.

OPERATIONS BEFORE 1918

According to Osler (1905), Valisneri of Padua, in 1719, was probably the first to report an operation for abdominal aneurysm. This physician correctly diagnosed the nature of a large pulsating tumour, but an unnamed surgeon, described as unskilful, lanced it with catastrophic results. Although the first recorded, it was probably not the first, nor the last, surgical operation of its kind. The first ligation of the aorta was in 1817, when Astley Cooper (1818) performed the operation at Guy's Hospital for an iliofemoral aneurysm threatening rupture. The patient died forty hours later, and in after years Astley Cooper (1835) referred to his having been "much abused for this operation". James (1830) next performed it at the Devon and Exeter Hospital, the patient surviving three hours. The wooden handle of the aneurysm needle broke during the operation, which, without anæsthesia, must have been one of astonishing difficulty. On reading James' account one wonders at his being able to do it at all. "As soon as the division of the parietes was effected, the viscera protruded, and the efforts of the poor fellow continuing strong, I soon found myself embarrassed with almost the whole of the bowels: nearly all the colon and a great part of the small intestines being pushed out, and presently quite distended with flatus." *The Lancet's* comment (1828–9, **2**, 607) was: "—an appalling operation, and we hope not to hear of its repetition—". Murray (1834) ligated the aorta by candlelight at the Civil Hospital, Cape of Good Hope. He at once wrote a short account of the case to catch the ship sailing for England the next day. A later mail brought news that the patient had survived only twenty-three hours. The fourth occasion was by Monteiro (1842) at Rio de Janiero. The patient lived ten days after a partially occluding ligature, dying of secondary hæmorrhage from the cutting of the knot into the aorta.

These 4 cases, and the 17 others prior to 1918 are tabulated by Bigger (1940) and Elkin (1940). Although they had all died within a short time, certain things had been learned from them. It seemed that complete occlusion of the aorta by simple ligature was very difficult to achieve, occlusions apparently complete at operation several times proving to be partial. It was realized that this was perhaps not a disadvantage, as partial occlusion gave a reasonable prospect of improving the aneurysm, with probably less risk than total occlusion. Apart from death from operative shock, to be expected in the early cases, the great danger was erosion of the aorta by the ligature. This had occurred even with partial occlusion, and with silk as well as with metal bands. One encouraging feature had emerged. Immediate occlusion of a degree sufficient to obliterate, at least temporarily, all distal pulsation was not normally followed by gangrene of the lower limbs, thanks to the collateral circulation already developed in these cases.

EXPERIMENTAL WORK BEFORE 1918

For some years Halsted (1905, 1909, 1913) tried to evolve a safe method of occluding the dog's aorta in one or more stages. He found that metal bands usually caused pressure necrosis of the vessel, but he had more success with strips of aorta and of fascia lata. Matas and Allen (1913) had similar experiences but were eventually able to divide the aorta after a series of progressively constricting aluminium bands. They demonstrated the greater safety of this in the abdominal aorta as compared with the thoracic, owing to the peritoneum, the presence of supporting tissues, and the organization of exudates.

OPERATIONS SINCE 1918

The abstracts which follow include all the cases which could be found in the literature of 1918 to 1950. They are numbered in sequence according to the date of publication. *Case* 22 has been included for completeness, although not a ligation or banding of the aorta. In nearly every instance the author was the surgeon, but where it is stated otherwise in the original report the name of the surgeon is given. Such cases have not been separately reported by the surgeon concerned.

Case 1 (Hamann, 1918).—Male, aged 51. Pulsating malignant tumour in pelvis. The aorta was ligated above the bifurcation with silk, tied so tightly that it was considered the intima was crushed. Pulsation in the tumour ceased at once and never returned. For a few days there was burning pain in the legs but subsequently movement and sensation were normal. From the third day there was faint pulsation in the femoral arteries. Pain was considerably relieved until death occurred six months later of hæmorrhage from a bed-sore. Autopsy showed the ligature embedded in the wall of the aorta, the lumen of which was not obliterated but was constricted to a diameter of 4 mm.

Case 2 (Vaughan, 1921; 1922).—Male, aged 39. Luetic aneurysm of the aorta at the level of the superior mesenteric artery. A distal ligature of cotton tape was applied, below the inferior mesenteric artery. This was tightened until pulsation was no longer felt in the iliac arteries and barely so in the aorta below the ligature.

Pulsation returned to the arteries of the left leg the following day, but never to the right leg. There was no disability as regards function and four months later the patient returned to full work as a bricklayer, the aneurysm greatly reduced in size. He continued well until two years after the operation, when he died following a sudden increase in the size of the aneurysm. At autopsy this was found filled with clot. The lumen of the aorta was constricted to 6 mm. in diameter; at one point the ligature had cut right through the intima. The left common iliac artery was patent, but the right was occluded by clot and connective tissue.

Case 3 (Matas, 1925; 1940).—Female, aged 28. Leaking luetic aneurysm of the terminal aorta, involving both common iliacs. The aorta was ligated below the inferior mesenteric artery with two cotton tapes, obliterating all pulsation distally. For some days the leg pulses were absent, but there was no evidence of deficient circulation. On the ninth day pulsation returned in the aneurysm and in the femoral arteries. Fourteen months later the aneurysm was half its previous size and had lost all its aneurysmal characteristics, having become a symptomless pelvic tumour. The left femoral pulse was still just palpable and the left lower limb was normal. The right femoral pulse had become obliterated during the preceding months and the leg was stiff from contractures, but this process had begun before operation as a result of syphilitic arthritis of the hip. The patient developed fulminating tuberculosis and died of hæmoptysis seventeen months after ligation of the aorta. Autopsy showed that the aneurysm was cured and filled with laminated clot. At the ligation site was a smooth stenosis of the aortic lumen, 2–3 mm. in diameter. The cotton tapes were completely incorporated in the wall of the aorta and had not caused any ulcerative or necrotic changes. Matas considered that stretching of the tape was responsible for the re-establishment of a small lumen nine days after ligation, and that this was an advantage rather than otherwise.

Case 4 (Reid, 1926).—Male, aged 36. Luetic aneurysm of the distal aorta. A cotton tape ligature was applied below the superior mesenteric artery, almost completely occluding the aorta. The femoral pulses returned in four hours and soon became strong. After a week they gradually became less and had disappeared in four weeks. Abdominal pain was relieved for a few weeks only. Three months after the first operation a second, completely occluding, tape ligature was applied above the cœliac and renal vessels. This had no obvious effect on the blood-supply to the lower limbs and renal function was unaffected. The patient died five weeks after the second operation. Autopsy showed that a second aneurysm had developed above the first and had ruptured through the diaphragm into the thorax. Both ligatures had cut through the aortic wall, but no hæmorrhage had ensued.

Case 5 (Brooks, 1926).—Male, aged 59. Luetic aneurysm of the terminal aorta. The aorta was ligated below the inferior mesenteric artery with a double turn of fascia lata, and 1 cm. lower with silk. All distal pulsation was obliterated. The legs were cold for twenty-four hours but quickly recovered their warmth. The aneurysm was much reduced in size and the patient returned to work as a truck driver. He died three months later of acute intestinal obstruction, a loop of small bowel having become adherent to the aneurysm. The latter was cured, being solid with organized clot at autopsy. The silk ligature had cut completely through the aortic wall and was embedded in the thrombus. Brooks comments that his case had only feeble pulsation in the femoral arteries before operation without any apparent circulatory deficiency, denoting an already adequate collateral circulation.

Case 6 (La Roque, 1931).—Female, aged 60. Aneurysm of the distal aorta. The aorta was ligated above the inferior mesenteric artery with tape, constricting the lumen to a diameter of 6 mm. and causing marked diminution of pulsation in the sac and femoral vessels. The patient lived three and a half years, with some improvement, and died probably of rupture of the aneurysm. (Operation performed by Watts.)

Case 7 (La Roque, 1931).—Female, aged 30. Luetic aneurysm of the right common iliac artery. The aorta was ligated below the inferior mesenteric artery with silk and cotton tape, completely occluding the lumen. Four days later a weak pulse returned to the left femoral artery. At three weeks the patient was walking about and feeling well. The aneurysm had shrunk to a small tumour without pulsation. At fourteen months she was well and working hard. A faint pulse in the left femoral artery was the only one present in either lower limb.

Case 8 (Reid, 1931).—Female, aged 35. Luetic aneurysm above the origin of the cœliac axis. The thoracic aorta was opened between temporary ligatures and a ball of fascia lata fixed within the lumen with transfixion sutures of silk. Six hours later no leg pulses could be felt, but the circulation was adequate. Death occurred twelve hours after operation from internal hæmorrhage. Autopsy showed that this had come from a divided intercostal artery and that the occlusion of the aorta was complete.

Case 9 (Reid, 1931).—Male, aged 57. Luetic aneurysm of the abdominal aorta. Insertion of a fascial plug into the thoracic aorta was intended, but the vessel proved too sclerotic and had to be divided between ligatures. Death occurred one and a half hours later from shock. (Operation performed by Andrus.)

Case 10 (Bigger, 1940).—Male, aged 54. Atheromatous aneurysm of the distal aorta and another of the right iliac artery. The aorta was ligated above the inferior mesenteric artery with fascia lata, obliterating all pulsation distally. Six hours later the right leg was pale and cold, but the left was normal and a faint pulse was present in the left femoral artery. At twelve hours the right leg showed areas of discoloration. Death occurred at eighteen hours. At autopsy the site of ligation permitted the passage of an ordinary probe. The aneurysm was largely filled with fresh clot. The right external iliac artery was occluded by old arteriosclerosis. Gangrene of the right leg was due to the previous circulatory deficiency being made extreme by clotting in the internal iliac artery.

Case 11 (Bigger, 1940).—Male, aged 25. Ruptured traumatic aneurysm of the distal aorta. This had followed a shotgun wound a year previously. The aorta was ligated above the inferior mesenteric artery with two turns of fascia lata, obliterating all pulsation distally. Two hours after operation the feet and lower legs were pale and cold. At sixteen hours they were warm and the colour had improved, but there was complete paralysis and diminished sensation. During the next three weeks there was gradual return of movement and sensation, and for much of the time severe pain in the legs. A second operation was performed a month after the first. The aneurysm was half its previous size and not pulsating. It was opened, having controlled the circulation by temporary silk ligatures on the common iliac arteries, and another proximal to the aneurysm. This had been left loosely around the aorta for the purpose at the first operation. The sac was filled with clot. Restorative endo-aneurysmorraphy was carried out. Silk was used to close the opening into the aorta, from which blood came out under considerable pressure. The sac was obliterated with silk sutures. When examined four and

a half months later, and again at one year, the patient was well and there was no sign of any mass in the region of the aneurysm. The lower limbs were normal and pulses were present in the femoral, popliteal, and posterior tibial arteries. Bigger believed the fascial ligature to have disappeared and that the lumen of the aorta had been fully restored.

Case 12 (Bigger, 1940).—Female, aged 28. Aneurysm of the distal aorta. The aorta was ligated above the superior mesenteric artery with tape, death occurring twenty-two hours later. (Operation performed by Watts.)

Case 13 (Elkin, 1940).—Male, aged 61. Atheromatous aneurysm of the terminal aorta. The aorta was ligated below the inferior mesenteric artery with two cotton tapes, 1 cm. apart, so as almost to obliterate pulsation distally. After operation there was some coldness of the legs for two days. Within a month the patient was back at work as a country minister, free from pain in the abdomen and legs from which he had suffered before operation, and with the aneurysmal mass much smaller and no longer pulsating. Eleven months later slight pulsation had returned in the aneurysm but he remained well. Elkin considered that partial occlusion of the aorta had allowed partial clotting to take place in the aneurysm.

Case 14 (Morton and Scott, 1944).—Male, aged 52. Leaking atheromatous aneurysm of the terminal aorta. The aorta was ligated below the inferior mesenteric artery with two cotton tapes, 1 cm. apart, so as almost to obliterate pulsation distally. The left leg, which had been swollen and œdematous before operation, developed gangrene and was amputated. Pulses and sensation were absent from the right leg for several days, but by the sixth day there was a good femoral pulse and thereafter it gave no further trouble. The patient was able to resume some of his office work, but he died seven months after the ligation, following attacks of melæna. Autopsy showed the aneurysm filled with organized clot, which extended into the left iliac vessels. A new aneurysm had formed proximal to the original one, due to the tapes cutting through the wall of the aorta. The tapes had also eroded an adherent loop of jejunum, into which a massive hæmorrhage had occurred.

Case 15 (Monahan, 1944).—Male, aged 49. Luetic aneurysm of the terminal aorta. The aorta was occluded in three stages, above the inferior mesenteric artery. The first stage consisted of partial occlusion with a rubber band, fixed with silk sutures. The second stage, three weeks later, consisted of complete occlusion with a second rubber band. Following this there was temporary coldness of the right foot. At the third stage, five weeks after the second, a silk ligature was applied as tightly as possible, just distal to the rubber bands, and at the same time both common iliac arteries were divided between silk ligatures. In the course of the operation the inferior mesenteric artery was torn and had to be ligated. The operation was followed by permanent pain and coldness in the right foot. The patient died of hæmatemesis three months after the third stage. Autopsy showed the aneurysm to be filled with old blood-clot. At the level of ligation there was a thick ring of fibrous tissue replacing the wall of the aorta and completely occluding the lumen. A small secondary aneurysm had formed immediately proximal to this ring, and at the same level there was a minute perforation from the aorta into the third part of the duodenum.

Case 16 (Ormond, Harkins, and Smith, 1944).—Male, aged 61. Leaking atheromatous aneurysm. As an emergency operation the abdominal aorta was ligated above the aneurysm with ribbon catgut. Death occurred eighteen hours later.

Case 17 (de Takats and Reynolds, 1947).—Male, aged 69. Atheromatous aneurysm of the terminal aorta. An 8-ply cellophane band was placed around the aorta, without constriction, near the level of the inferior mesenteric artery. At eight months the aneurysm was decidedly smaller. At thirteen months it was one-third of its previous size. The relief from pain was striking. The patient died fourteen months after operation from internal hæmorrhage.

Case 18 (de Takats and Reynolds, 1947).—Male, aged 55. Atheromatous aneurysm of the terminal aorta. An 8-ply cellophane band was placed round the aorta below the inferior mesenteric artery, and an 8-ply sheet placed over the anterior surface of the aneurysm, rupture of which appeared to be imminent. At three months the mass was one-third of its previous size and there was complete relief from the severe pain which had caused the patient to seek treatment. At fourteen months he was well and working a full day. A hard mass was palpable where the cellophane sheet had been placed. Death occurred two years after operation, probably from recrudescence of the aneurysm.

Case 19 (de Takats and Reynolds, 1947).—Male, aged 57. Atheromatous aneurysm of the distal aorta. Eight thicknesses of cellophane were placed round the aorta above the inferior mesenteric artery. There was no subsequent change in the aneurysm or in the symptoms. The patient died eight months later from coronary occlusion. At autopsy the cellophane was embedded in fibrous tissue anteriorly, but posteriorly it lay free between the aorta and the vertebral column. The fibrous reaction included granulation tissue and showed marked inflammation. The lumen of the aorta was not constricted, but there was laminated clot lining the aneurysm and reducing its lumen to that of a normal aorta. The authors consider that this patient had cured his aneurysm by partial thrombotic occlusion and that, though the cellophane had caused fibrosis, there was no evidence that it had played any part in the cure.

Case 20 (Blakemore, 1947).—Describing his technique for wiring and endothermic coagulation, Blakemore mentions that his patient had undergone ligation of the aorta with tape some months previously. The tape had cut through and there was another small aneurysm at the site of the ligation.

Case 21 (Rea, 1948).—Male, aged 36. Atheromatous aneurysm of the distal aorta. The aorta was ligated proximally with two turns of fascia lata, reducing the blood-flow by an estimated 80 per cent. Symptoms were not much relieved and the aneurysm continued slowly to increase in size. Four years after the first operation a second exploration was carried out. A non-constricting band of polythene, variety unspecified, was placed around the upper end of the aneurysm. Another piece, 6 × 9 cm., was sutured over an atheromatous plaque on its anterosuperior aspect. At the same time a small piece was implanted in the abdominal wall in order to study the amount of fibrosis produced. Four months later symptoms were partly relieved and the aneurysm seemed to be smaller. There appeared to be little fibrosis around the implanted piece of polythene. Death occurred from coronary thrombosis seven months after the second operation. At autopsy there was some fibrous thickening and constriction of the aorta at the site of ligation, but it was impossible to tell whether this was the result of the fascia or the polythene as no trace of either could be found. The aneurysmal wall was thickest where the polythene patch had been applied, but this had also disappeared. (First operation was performed by Pemberton.)

Case 22 (Yeager and Cowley, 1948).—Male, aged 64. Atheromatous aneurysm of the terminal aorta.

This involved and pressed on the left common iliac artery, and there were no pulses in the left lower limb, the foot being cold and ischæmic. Strips of polythene (du Pont) were applied to the whole of the anterior and lateral surfaces of the aneurysm after temporary reflection of the peritoneum. Two months later the aneurysm was one-third of its previous size, pain had disappeared, and the circulation in the left leg was greatly improved, with all pulses present and a warm foot.

Case 23 (Aird, 1949).—Aird briefly refers to an aneurysm of the distal aorta successfully treated by cellophane wrapping and ligature. Part of the cellophane was passed by rectum a year later.

Case 24.—The thoracic aorta was partially occluded with a metal band for a luetic aneurysm of the abdominal aorta. The following is a short note on this previously unpublished case :—

The patient, a man aged 48, was admitted to University College Hospital complaining of pain in the abdomen and back for a year, swelling of the abdomen, and vomiting. He was obviously ill. A large mass, having expansile pulsation, filled the left side of the abdomen. He gave a history of syphilis twenty-four years previously and there was the scar of an old syphilitic ulcer below the left knee. Operation was performed by Mr. Gwynne Williams on Nov. 15, 1929. Abdominal exploration having shown the aneurysm to extend too high for ligation by that route, the thoracic aorta was exposed extrapleurally, using a posterior vertical incision with resection of parts of the 4th to the 7th ribs. An aluminium band, 1·3 cm. wide, was placed round the aorta and tightened until pulsation in the right calf was only just detectable by oscillometry. Two days later the feet were warm and of good colour. The left dorsalis pedis pulse was just palpable, but not the right. On the eighth day there was a sudden deterioration in his condition and he vomited. Death occurred the following day. At autopsy the stomach was greatly dilated, and this was the immediate cause of death. Syphilitic aortitis was confirmed. The wall of the aneurysm was composed of the bodies of the lumbar vertebræ, the left crus, posterior abdominal wall, spleen, kidney, and diaphragm. The opening from the aorta measured 8 × 4 cm. and was in its left wall immediately above the bifurcation. There is no record of the appearance of the ligated thoracic aorta or the degree of constriction present.

EXPERIMENTAL WORK SINCE 1918

In order to avoid the local necrosis so often caused by the pressure of bands or ligatures, Reid (1924) partially occluded the aorta in dogs with non-penetrating mattress sutures placed so as to produce an infolding of the wall. Over periods of two to eight months the partial occlusion persisted unchanged. The intima proliferated so as to bridge over the crevices made by the infolding, with a consequent tendency towards the restoration of a circular lumen. Reid was also successful in producing occlusion with plugs of rolled-up fascia anchored in the lumen with silk sutures. These became well incorporated into the vessel wall and within a few months their free surfaces were covered with intima. He later used this method in *Case* 8. Pearse (1928, 1932, 1940) made a number of contributions from the experimental side. He introduced a coiled metal spring into the aorta of dogs and found this produced a total occlusion by thrombosis, which later recanalized with a small lumen. The operation was simple and safe, consisting merely of screwing in the spring through the puncture made by its pointed end. Silver wire was less effective than steel in causing thrombosis. He found fascia, even six to eight turns around the aorta, quite ineffective in producing occlusion. This was usually owing to stretching, but if this did not occur the aortic wall became thin and sometimes ruptured. Sclerosing fluids were useless, either injected into the lumen of a clamped-off segment or around the aorta beneath the adventitia. External application of strong iodine or silver nitrate was without effect and only electrocoagulation of the wall, to a degree short of producing necrosis, caused a slight temporary narrowing. His greatest success was with cellophane wrapping and he was the first to show that this was a practicable method.

Owings and Hewitt (1942) perfected a multistage technique which allowed eventual division of the aorta in dogs with safety and with indefinite survival. Gradual narrowing was brought about by applying progressively tighter rubber bands at intervals of a few weeks. This work was done on the thoracic aorta, a much harder test than the abdominal aorta of any method of occlusion. Cooper, Robertson, Shea, and Dennis (1949) successfully occluded the aorta in dogs with a band of tantalum, this being prevented from making contact with the aortic wall by an underlying wider band of polythene. Other experimental work of recent years has been almost entirely concerned with the effects of plastics wrapped round the vessel and is considered later in the discussion on cellophane.

AUTHOR'S CASE

The present case is fully reported in order to add something to the total of knowledge concerning this condition. Unusual features were the pre-operative obstruction of the sigmoid colon and the post-operative diarrhœa. The former was sufficiently marked to obstruct a barium enema completely, yet there was no organic narrowing and it was only at autopsy that hypertrophy of the proximal sigmoid was demonstrated. The obstruction was presumably neurogenic and comparable with the syndrome described by Ogilvie (1948). The post-operative diarrhœa was thought to be due to a reversal of this state of autonomic imbalance following interference with the sympathetic plexuses at operation. As regards the ligation of the aorta it was clear, in retrospect, that the the tape ligature should have been applied more tightly.

Case 25.—**Male, aged 65. Atheromatous aneurysm of the distal aorta. Partial proximal occlusion of the aorta with cellophane and cotton tape ligatures. No improvement. Death after twenty-five days.**

HISTORY AND EXAMINATION.—The patient attended on June 1, 1949, complaining of abdominal pain and constipation of two months' duration and the loss of 35 lb. in weight. Except for signs of recent weight-loss clinical examination revealed nothing abnormal. A barium enema would not flow past the middle of the sigmoid colon. A provisional diagnosis was made of carcinoma at this site. By the time of his admission to the Bristol Royal Infirmary, six weeks after he was first seen, the pain was worse and he looked more ill. A swelling, with expansile pulsation, was present at and above the umbilicus. Neither bruit nor thrill was present. Opinions differed as to whether this was an

aortic aneurysm or a large aorta unduly palpable in a very thin patient. There was no radiological evidence of calcification of the aorta or of erosion of the vertebræ. The blood-pressure was 140/90; Wassermann and Kahn tests were negative.

At Operation (July 3).—The colon did not appear to be abnormal and there was no organic cause for the obstruction of the sigmoid which had been noted on radiography. A fusiform aneurysm of the aorta, with a maximum diameter of 8 cm., extended from a little below the renal arteries to the bifurcation (*Fig.* 622). Throughout most of its extent the wall felt firm and thick, and it

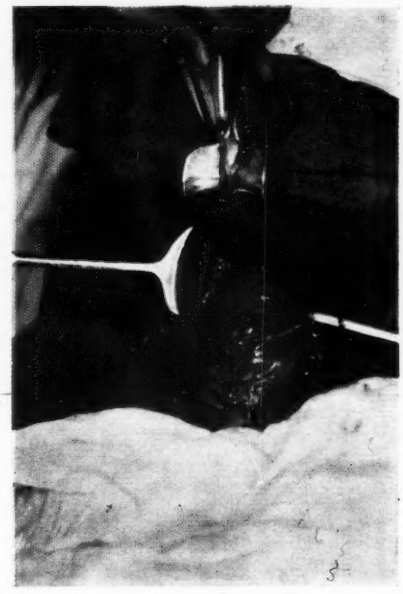

Fig. 622.—The aneurysm at operation, with a loop of cotton tape around the aorta proximally.

was adherent to neighbouring structures by reason of a chronic inflammatory reaction, with fibrous tissue much in evidence. Over its most prominent part, about the middle of the aneurysm, it felt soft and thin. After displacing the root of the mesentery and the third part of the duodenum upwards, a cotton tape was passed around the aorta about 2 cm. below the renal and superior mesenteric arteries and immediately above the beginning of the aneurysmal dilatation. The aorta appeared relatively normal at this level, but the periaortic tissues were densely matted. A strip of cellophane (Cellophane P.T.), taken from the wrappings of a blood transfusion set and boiled, was folded into four thicknesses to make a band 0·5 cm. wide. This was tied around the aorta, at the same level, tightly enough to reduce the pulsation considerably. The thin-walled part of the aneurysm was investigated further, by reflecting the peritoneum covering it. This confirmed that the wall here was no more than a millimetre or so thick, and that it was not far from rupturing. Two sheets of cellophane, single thickness, overlapping to conform to the convexity of the aneurysm, were applied to an area about 4 cm. square and the peritoneum sutured in place over them. The tape ligature, hitherto kept on a half knot as a safety measure in case of injury to the aneurysm, was tied, more tightly than the cellophane band. The degree of constriction produced was difficult to determine exactly, but the aneurysmal pulsation was greatly reduced, from a violent thrust to something less than the pulsation of a normal aorta. The impression at the time was that the blood-flow had been reduced by at least one half.

Post-operative Course.—Following operation, the pulses in the lower limbs were only slightly, if at all, reduced in volume. At no time were there any symptoms of circulatory deficiency. The pain was not relieved by the operation and the abdominal pulsation was much as before. On the fifth day he started to have diarrhœa, up to six to eight times daily, with a lot of mucus. This continued until the time of his death. His general condition showed little change until he collapsed and died suddenly twenty-five days after the operation.

At Autopsy.—The peritoneal cavity was full of blood, the aneurysm having ruptured at the bifurcation, several centimetres below the limits of the cellophane application. The cellophane and tape ligatures proximal to the aneurysm were intact, and the lumen of the aorta was here narrowed to a diameter of 7 mm. After cutting the ligatures and opening up the aorta at this point, its internal circumference measured 4 cm., and it was evident that the constriction had been maintained by the tension of the ligatures as well as by cicatricial contracture. The inflammatory reaction around the aorta was much more marked, at the level of ligation especially, than at operation. In places the fibrin and fibrous tissue formed a layer 1 cm. thick. The cellophane sheets had slipped, upwards and downwards respectively, from the crown of the aneurysmal prominence. Each piece lay within a shallow cavity of fibrous tissue with a smooth lining. A noticeable feature was that the fibrous tissue was three or four times as thick over the most prominent part of the aneurysm, which was bare of cellophane, as over the adjoining cellophane-covered areas. Histology confirmed the relatively small amount of fibrosis in the area in direct contact with the cellophane compared with that alongside it. The proximal half of the sigmoid colon showed considerable hypertrophy, and its muscular wall was double the thickness of the distal half, but there was nothing to account for the obstruction noted before operation.

DISCUSSION

For a readier appraisal of the main features, 18 of the cases among the abstracts have been set out in *Table I.* The others have been omitted on account of insufficient published detail or too short a survival period. They are a mixed collection with regard to age, sex, cause (in 8 of the aneurysms the cause was atheroma, in 6 syphilis, in 1 trauma, and in 2 the cause was not stated, the 18th case was for a tumour), situation, size, and effects produced. Ligatures of various materials were applied to the aorta at various levels, to produce immediate total occlusion, immediate partial occlusion, or delayed occlusion. In fact there are hardly two comparable cases and it is obviously impossible to evaluate any of the methods used by the results alone. As to the latter it is evident that they are generally poor in terms of long-term relief and survival. At most, 6 cases can be regarded as successful and 5 as partly successful, while 7 are failures. Of the 7 cases not tabulated, 4 died within a few hours of operation. Seeing that successes have probably been reported more regularly than failures, the general picture is not a bright one. However, we are dealing with a condition most difficult to treat and, as has been stated earlier, of admittedly very bad prognosis. Cases coming to operation have mostly been advanced ones, already with serious symptoms of leakage or severe pain. It is in relation to this that the high mortality and, even when symptoms have been relieved, the often short survival period must be viewed.

Although strict comparisons cannot be made, there are a number of points of practical importance which emerge from a consideration of the tabulated cases :—

Table I.—SELECTED CASES OF ABDOMINAL ANEURYSM, 1918–1950

Case No. of Abstract, Author, Year of Publication	Ligation Above or Below Inferior Mesenteric Artery	Degree of Occlusion of Aorta		Material	Ill Effects of Ligation		Good Effects of Ligation		Survival	Cause of Death
		As Judged at Operation	Ultimate		Evidence of Local Harm	Permanent Effects on Lower Limbs	on Aneurysm	on Symptoms		
1. Hamann (1918)	Below	Complete	Partial	Silk	None	None	No aneurysm	Relief	6 mth.	Hæmorrhage from bed-sore
2. Vaughan (1921)	Below (distal ligation)	Partial	Partial	Tape	None	None (though absent pulses)	Improved	Relief	2 yr.	Aneurysm
3. Matas (1925)	Below	Complete	Partial	Tape	None	None (on normal limb)	Cured	Relief	1½ yr.	Tuberculosis
4. Reid (1926)	(*a*) Above	Partial	Partial	Tape	None	None (though absent pulses)	None	None	4 mth. from 1st operation	Rupture of 2nd aneurysm
	(*b*) Above renals 3 mth. later	Complete	Complete ?	Tape	2nd aneurysm	None	None	None		
5. Brooks (1926)	Below	Complete	Complete	Fascia	None	None	Cured	Relief	3 mth.	Intestinal obstruction
6. La Roque (1931)	Above	Partial	Partial	Tape	None	None	Doubtful	Relief	3½ yr.	Rupture of aneurysm
7. La Roque (1931)	Below	Complete	Partial	Silk and Tape	None	None	Cured	Relief	Well at 14 mth.	
10. Bigger (1940)	Above	Complete	Partial	Fascia	Time too short	Gangrene R. (external iliac artery was occluded before operation)	Time too short	Time too short	1 dy.	Operation
11. Bigger (1940)	Above	Complete	Complete	Fascia	None	None (though severe ischæmia several weeks)	Improved (later cured by aneurysmorraphy)	Relief	Well at 1 yr.	
13. Elkin (1940)	Below	Partial	Partial	Tape	None	None	Improved	Relief	Well at 11 mth.	
14. Morton and Scott (1944)	Below	Partial	Partial	Tape	Eroded jejunum 2nd aneurysm	Gangrene L. (circulatory deficiency before operation)	Cured	Relief	7 mth.	Hæmorrhage into jejunum
15. Monahan (1944)	(*a*) Above	Partial	Partial	Rubber	Rubber band eroded duodenum 2nd aneurysm	Ischæmia R.	Cured	Relief	3 mth.	Hæmorrhage into duodenum
	(*b*) Above	Complete	Complete ?	Rubber						
	(*c*) Above	Complete	Complete (with division of both common iliac arteries)	Silk						
17. de Takats and Reynolds (1947)	?	None	Partial	Cellophane	None	None	Improved	Relief	14 mth.	Hæmorrhage
18. de Takats and Reynolds (1947)	Below	None	Partial	Cellophane	None	None	Improved	Relief	2 yr.	Aneurysm
19. de Takats and Reynolds (1947)	Above	None	None	Cellophane	None	None	None	None	8 mth.	Coronary thrombosis
20. Blakemore (1947)	?	?	?	Tape	2nd aneurysm	None	None (later cured by wiring)	None	Alive some mth.	
21. Rea (1948)	(*a*) Above	Partial	Partial	Fascia	None	None	None	None	4½ yr.	
	(*b*) Above 4 yr. later	Partial	Partial	Polythene	None	None	Improved ?	Relief ?	7 mth.	Coronary thrombosis
25. Present Case	Above	Partial	Partial	Tape and Cellophane	None	None	None	None	3 wk.	Rupture of aneurysm

1. In cases of aneurysm ligation of the aorta above the origin of the inferior mesenteric artery carries no extra risk. In none of the 7 cases where this was done was there anything clinically or at autopsy to indicate an impaired blood-supply to the left colon. In three of them the aortic occlusion was probably complete.

2. Complete occlusion cannot be expected to follow a simple ligature in continuity, no matter how tightly applied, which is a well-known feature of the ligation of large arteries. In *Case* 5 occlusion was still complete three months later, but in *Cases* 1, 3, 7, and 10, thought to be complete occlusions at operation, subsequent events proved otherwise. There are various ways in which this may come about. The ligature may never have actually caused a total occlusion, probably the explanation in *Case* 10. It may stretch, as in *Case* 3, or it may cut through into the lumen, with the formation of a new channel outside the ligature. This latter process has been shown to occur in experimental ligation (Horsley, 1925), as well as in other large arteries in man, and there is an example—*Case* 2—in this series.

3. Tape is the favoured material for immediate occlusion, either total or partial. It is well tolerated by the tissues and its pressure is better distributed than in the case of a silk ligature. Should it cut into the lumen there is likely to be more time for a protective wall of fibrous tissue to form outside.

4. The chief danger of a ligature is that it may so weaken the wall of the aorta that a second aneurysm forms (*Cases* 4, 14, 15, and 20). It may also erode adherent intestine (*Cases* 14 and 15).

5. The risk of serious impairment of the circulation in the lower limbs is small, provided it is good beforehand. Several reports mention a few hours' coldness and pallor, but only in *Case* 15 was the ischæmia permanent. *Cases* 10 and 14 developed gangrene, but in both the blood-supply was already compromised. It is clearly important to assess the circulation in the lower limbs when contemplating aortic ligation. Necessity may force the taking of a risk, but it is a much greater one when there is pre-existing circulatory insufficiency, and this should be given due weight in deciding on treatment. The problem is a complicated one, for in *Case* 5 the iliac arteries were already partially obstructed before ligation of the aorta was carried out and the operation caused only transitory symptoms of circulatory disturbance, whereas in *Case* 11, an otherwise healthy young man, the pre-operative leg pulses were normal and ligation caused severe symptoms for some weeks. Before operation in *Case* 5, however, there were no signs of affection of the circulation other than the weak pulses, evidence that a good collateral circulation existed, and this is probably the type of case least likely to suffer any ill effects.

6. Simple proximal ligation, with tape or fascia, can cure the aneurysm. This is so whether occlusion is complete (*Case* 5), or partial (*Cases* 3, 7, and 14). When it fails to cure it can bring about a reduction in size and pulsation (*Cases* 11 and 13). Improvement in the aneurysm was always accompanied by relief of symptoms.

7. Cellophane banding of the aorta, without immediate occlusion, brought about a regression of the aneurysm in 2 out of 3 cases. Cellophane ligation alone may have improved one case, while together with tape ligation, it failed in one. Cellophane application to the aneurysm alone was followed by remarkable improvement in *Case* 22.

CELLOPHANE

Page (1939) demonstrated the irritating properties of cellophane when he wrapped the kidneys of dogs in this material to produce hypertension. A purulent exudate formed, followed by a dense fibroblastic and collagenous deposit, which contracted down on the kidney. Graef and Page (1940) described the changes in more detail, and found in one case marked constriction of the renal artery. Pearse (1940) was able to produce complete occlusion of a dog's aorta some months after wrapping with cellophane, but by no means invariably as it apparently occurred only twice in twenty-four experiments. Harrison and Chandy (1943) were the first to report its use for occluding arteries in man. They applied it to the subclavian artery in two cases of subclavian aneurysm. One aneurysm eventually disappeared after nineteen months, but the circumstances were such that it must be doubted whether the cure was in fact a result of the treatment. The second operation failed through sepsis. Gross (1944) and Harper and Robinson (1944) used it with success for occluding a patent ductus arteriosus.

The experiences of Wheeldon (1939), McKeever (1943), and Harley and Breck (1945) were in complete contrast to those mentioned. They used cellophane successfully as an interposition membrane to prevent adhesions after arthroplasty, synovectomy, and operations on tendons. In an attempt to reconcile these divergencies Poppe and de Oliveira (1946) investigated the different types of so-called cellophane. They appear to have been the first medical authors to differentiate between cellophane and polythene and to attempt an estimate of the irritating properties of each. Their other contribution was the suggestion that reactive plastic films might be covered with a sheet of an inactive variety if it was desired to limit the fibrous reaction. Their published findings that polythene was reactive and cellophane inactive, were soon shown to be an over-simplification, as well as incorrect, although supported by Abbott (1947). Brown, Grindlay, and Craig (1947) found polythene completely non-irritating, as did the next group of workers, whose contribution merits consideration in some detail.

Ingraham, Alexander, and Matson (1947), in a general review of plastics used in surgery, defined the properties of cellophane and polythene. Cellophane is a plasticized cellulose product, strongly irritating to the tissues. Polythene (otherwise known as polyethylene) is polymerized ethylene and a comparatively simple substance, as it consists of a long chain of carbon atoms, each attached to two hydrogen atoms. If pure it is entirely inert. In theory it should be pure as no plasticizer is needed to give it special physical characteristics. The full details of manufacture were regarded as trade secrets and were not available to them, but as far as they could find out no plasticizer was normally added. There was, however, a possibility of contamination with these substances by the polythene passing through machines previously used for extruding

cellophane sheet. From the commercial aspect such contamination would be of no account, but it might make the polythene irritating to the tissues, so accounting for at any rate some of the conflicting results. Although they regarded cellophane as essentially an irritating substance, they considered that there might well be certain types less irritating than others. Ingraham and his colleagues brought order to the confusion of conflicting ideas which existed prior to the appearance of their report. They were the first to define, in medical literature, the chemical and other differences between polythene and cellophane, and their views in general on the respective properties of these two materials have been confirmed by almost all subsequent investigations.

Yeager and Cowley (1948) carried the matter a stage farther by emphasizing the distinction between pure and impure polythene. The pure variety, made by extruding the melted material as a film, is completely inert. The impure variety, made by casting from a solution on to rollers, contains a small amount (less than 1 per cent) of dicetyl phosphate, which is responsible for its irritating effects on the tissues. They ascertained that polythene made by the du Pont company was of the latter type. Its reactive properties, when wrapped around the aorta of dogs, were confirmed by Cooper and others (1949). Grindlay and Mann (1948) found that pure polythene film produced no reaction in the tissues of dogs, whether implanted subcutaneously, into the muscles, or in the peritoneal cavity, while Condon and Harper (1949) used it many times as a permanent packing after extrapleural pneumolysis and observed no inflammatory reaction.

The irritating effect of cellophane was confirmed by Wilson (1948) and Weckesser, Shaw, Spears, and Shea (1949). The former obtained poor results from wrapping tendons in cellophane and found that small pieces of cellophane sheet implanted in the rabbit produced a bursa-like space with a smooth lining. The latter group used it to wrap tendons in dogs after division and suture. They found that the cellophane diminished adhesions between the tendons and tissues by the formation of a smooth bursa between them. Histology showed no inflammatory reaction in the tendon but a moderate reaction in the surrounding tissues. These observations and the preceding ones of Wilson are interesting in view of the similar finding of a bursa-like space surrounding the cellophane sheets in the case here reported. Le Veen and Barberio (1949) found that the injection of fine particles into the tissues caused marked fibrosis and suggested that this method might be more effective than wrapping owing to the intimate contact of a very large surface of the material. The only conflicting report of recent years, claiming inertness for cellophane, is that of Duncan and Goodwin (1949), who used polythene and cellophane together to produce experimental ureteric obstruction. They furnish no histological or other evidence to support their view that the resulting fibrosis was due to the polythene only. A possible danger from implanted cellophane has been referred to by some authors. Oppenheimer, Oppenheimer, and Stout (1948) found that 35 per cent of rats developed sarcoma at the site within a year. Spontaneous sarcoma was stated to be rare in the strain of rats used, but no control series is mentioned.

At the present time it appears justifiable to summarize the position as follows: Pure polythene is uniformly inert; polythene containing dicetyl phosphate is certainly reactive; cellophane is reactive but subject to considerable variation. Cellophane has, or some varieties have, a tendency to form bursa-like spaces in the tissues. It is clear that further studies are needed, particularly in man, to determine the tissue response, in quality and quantity, to various plastic films.

From the practical aspect, whatever plastic is used the remainder of the sheet from which it was cut should be identified and stored away for use in other cases if it proves effective. At present it is not possible to buy, nor apparently to manufacture, plastic film with a predetermined degree of reactivity (other than non-reactive pure polythene). Pending the advent of such a substance the temporary solution is to identify suitable specimens by trial and error, and for those in possession of proved reactive material to make it available to others. Reactivity in animals may well prove misleading; in the present state of knowledge it is probably safer to rely on a known effect in human tissues. Even here there may be confusing factors of differences between individuals and between types of tissue. Further information can be obtained if, at the same time as a plastic material is buried deeply, one or more small pieces are placed subcutaneously or intramuscularly in the abdominal wall, to allow close study as time passes. When there is no urgency in regard to treatment, specimens of different plastics could be implanted beforehand and the most promising selected for the major procedure a few months later.

The only manufacturers of cellophane in this country, British Cellophane Ltd., have been kind enough to inform me that the plasticizers used to soften their product are glycerin and urea, in proportions varying from 13 to 25 per cent. The gradual extrusion of these substances into the immediate vicinity of the cellophane, with a consequent osmotic effect, may account for the bursa-like spaces which have been noted. It is unlikely that they influence the fibrotic reaction, which must be attributed to the cellulose basis of the cellophane.

Information about polythene has been kindly supplied by Imperial Chemical Industries Ltd. They are the only producers of polythene in Britain and, at the present time, themselves manufacture all the polythene film sold here. They use the melt extrusion process and their product is, in consequence, pure polythene and therefore almost certainly inert. As has been pointed out earlier, du Pont polythene film, widely used commercially in the United States, contains dicetyl phosphate and is reactive. It is likely that other British firms will be manufacturing polythene film in the near future. Depending on the process used, and the incorporation of a stripping agent, this may be of a reactive type.

CONCLUSIONS

1. Surgery should be seriously considered in cases of aneurysm of the abdominal aorta with symptoms. Provided the patient is fit for operation

in other respects the only contra-indication is radiological evidence of severe aortic calcification. This is likely to make impracticable any surgery of the aorta or the aneurysm, but its degree is only fully discoverable at operation.

2. At the present time operation is not justified in cases without symptoms. As in other fields of surgery, there is probably more than one method of treatment, but not enough is known of the methods already employed, the technical difficulties have not been solved, and the risk of doing harm rather than good is considerable.

3. Apart from wiring and endothermic coagulation—improved versions of which may well prove successful in the future, either alone or in conjunction with the methods here discussed—the most promising treatment seems to be proximal ligation of the aorta combined with the application of an irritating plastic film to the aneurysm itself.

4. Whether the aortic ligature should be immediately or gradually occluding is open to question. Immediate constriction risks erosion or thinning of the aorta and a secondary aneurysm which is prone to rupture. Gradual occlusion, as by a cellophane band, is slow in its effects and therefore not suited to cases threatening rupture, and furthermore uncertain, in that a satisfactory reaction of the tissues cannot be guaranteed. The advantages of both methods are obtained by applying a wide collar of the plastic material over which one or more tape ligatures are tied.

5. It is not possible to do more than offer a suggestion as to how much occlusion should be produced at operation, but it would seem that, when rupture of the aneurysm threatens, the ligatures should obliterate all distal pulsation. It is a matter of balancing the risks, and should there be signs of impaired circulation in the legs before operation it would be better to compromise with a subtotal occlusion. When rupture of the aneurysm is not an imminent danger the ligatures should be drawn only tightly enough to produce a moderate reduction of the lumen and of pulsation.

6. Occlusion, either total or partial, is no more dangerous above than below the origin of the inferior mesenteric artery. Above the renal arteries total occlusion must surely be the more dangerous procedure, though there is no direct evidence to prove this. Ligatures, as well as any plastic material applied to the free surfaces of the aneurysm, should be well covered over with peritoneum to prevent adhesion of intestine.

7. Cellophane, the ordinary plain transparent variety known as P.T., is a suitable plastic to use. Polythene containing dicetyl phosphate merits further trial and may prove better. Until plastics of known reactivity are available, the sheet from which any material employed was cut should be put on one side for later use if it proves to be a suitable variety. Small pieces should be embedded in accessible situations for study at intervals, and this method may be used pre-operatively, in cases of no urgency, to allow the best material to be selected.

8. Cases should be reported, failures as well as successes. The condition is by no means rare and the possibilities of surgical treatment have as yet hardly been explored.

SUMMARY

An account is given of the early history of the surgery of abdominal aneurysm. Experimental work aiming at safe occlusion of the aorta is summarized. Abstracts are presented of published cases of aortic ligation since 1918, a further case is reported in detail, and an attempt made to evaluate the methods used. The history and use of cellophane and other plastic films are described. Surgical treatment for abdominal aortic aneurysm with symptoms is advocated and suggestions are made as to how this should be carried out.

I have to thank Mr. Gwynne Williams for allowing me to publish notes of his case (*Case* 24), and Professor R. Milnes Walker for his help and advice at the operation on *Case* 25.

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SOME OBSERVATIONS ON THE DIAGNOSIS OF CLINICALLY PIGMENTED SKIN TUMOURS

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THERE are, from time to time, in the experience of most of us, occasions when we are first made acutely aware of some new piece of knowledge of which we had previously been quite ignorant. This sudden realization may follow the stimulating teaching of a respected teacher of rich experience, or the chance encounter in unusually quick succession with what should be one's life quota of a clinical rarity. There is, however, no lesson which is so bitter and so cruelly unforgettable as that which follows the making of a major blunder. It was the humiliation of a mistaken diagnosis which prompted the inquiries of which this paper is the result.

CASE REPORTS

Case 1.—In the autumn of 1949 there first came under our care a young woman who gave the following history: At the age of 19, or thereabouts, she first noticed a small brown "mole" on the front of her left thigh. This was observed to grow steadily and, six months later, when it had become distinctly unsightly, she consulted her doctor, who removed it in his surgery under local anæsthesia. Unfortunately, the excised tumour was not sectioned. The operation was apparently successful but eight months later a precisely similar brown tumour was discovered in the scar, and this in turn gradually enlarged in the eight months which elapsed before she sought advice at her local hospital. There, a diagnosis of malignant melanoma was made and she was referred to Hammersmith Hospital for further treatment. The tumour had neither bled nor ulcerated: it had, in fact, caused very little trouble apart from some slight discomfort under firm pressure and occasional itching.

When we first saw her in November, 1949, the tumour measured roughly 2 cm. across (*Fig.* 623). It was flat, rather less than hemispherical, and was situated about the middle of the anteromedial aspect of the left thigh. Its surface consisted of smooth, stretched, but intact skin. It was evenly pigmented, but not deeply so, and there was no sign of spillage of the pigment into the adjoining skin. Such hair as was growing in the vicinity was no different in texture and in colour from that elsewhere on the thigh. The tumour was rather soft and seemed to be in part compressible and perhaps even fluid-containing, but it did not pulsate. It was fixed in the skin but moved freely on the underlying muscle and fascia. There was no sign of the scar of the earlier excision, which must clearly have been a somewhat limited one. Above and lateral to this main tumour, and separated from it by a few centimetres, was a second, small, pigmented, but clearly dissimilar tumour. It was not raised above the surface of the skin and had the clinical features of a common benign mole, of which there were several other examples on the back and on the medial aspect of the left upper arm. No enlarged glands could be felt in either groin or in the lower abdomen.

A B

FIG. 623.—*Case* 1. A, Sclerosing angioma which had recurred following its attempted removal 16 months previously. B, Close-up view of the tumour. The small pigmented spot lying above it had the clinical features of a simple melanoma.

In view of the history and of the clinical findings, the provisional diagnosis of malignant melanoma was sustained (although it is fair to add that when we consulted our colleagues there were one or two dissenting voices). Believing biopsy in such cases to heighten the risk of early

and wide dissemination should it turn out to be a malignant growth, we took no further steps to establish the diagnosis. A gloomy prognosis was given to her parents and it was hinted that postponement of her imminent marriage would be well-advised.

OPERATION.—On Nov. 16 an extensive resection was carried out, including a wide triangle of skin

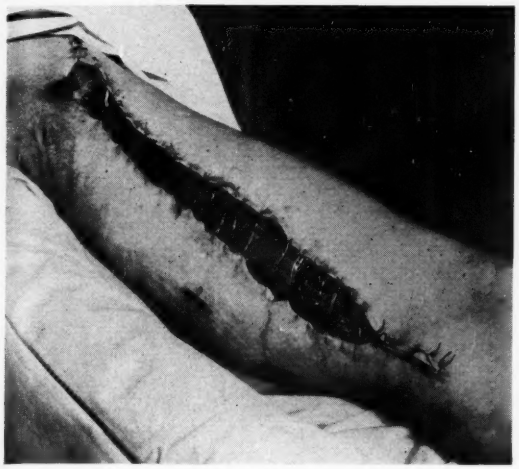


FIG. 624.—*Case* 1. Photograph taken at the time of the first dressing to show the extent of the excision.

outlined by the adductor tubercle and the pubic and anterosuperior iliac spines. The line of section passed about 3 cm. beyond the outer edge of the tumour and the deep fascia was removed (*a*) on the outer side, from the lateral margin of sartorius above and the middle of the belly of vastus lateralis below, and (*b*) on the inner side, as far as the medial margin of adductor longus and magnus. The dissection was extended above the inguinal

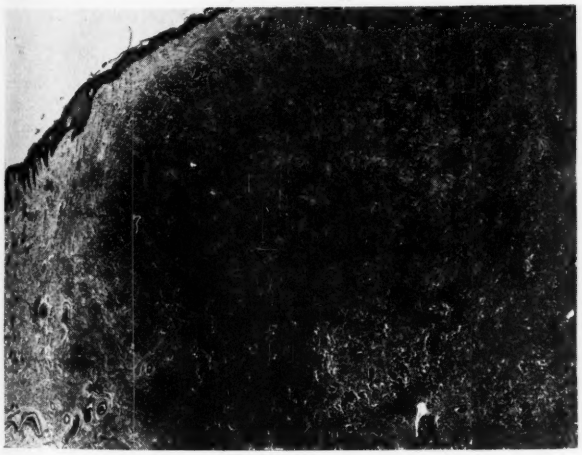


FIG. 626.—*Case* 1. This shows the richly cellular tumour in the dermis. (H. E.) (× 9.)

ligament, and the block of tissue, which was removed in one piece, contained not only the skin with the tumour and a wide area of fascia but the saphenous vein and its terminal tributaries and the inguinal and external iliac group of lymph-glands.

It was not possible even after widely undermining the skin-flaps, to get complete skin cover. Partial apposition was achieved by a lacing of interrupted sutures of stainless steel, tied over a tulle gras dressing (*Fig.* 624). Her further treatment was undertaken by Mr. J. N. Barron, our consulting plastic surgeon, when a long granulating defect was successfully covered by a Thiersch graft taken from the same thigh.

When last seen in June, 1950, there was no sign of recurrence, but she was left with a most unsightly scar and had slight residual œdema of the ankle, most apparent in warm weather.

PATHOLOGY.—The first pathological report confirmed our clinical diagnosis of malignant melanoma, the glands, however, being apparently unaffected. The seriousness of the situation was once again communicated to the girl's parents, although the apparent absence of lymph-borne

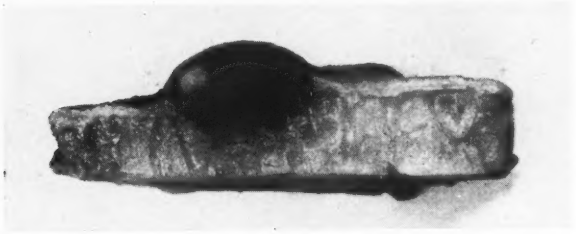


FIG. 625.—*Case* 1. Section cut across the tumour to show its position in the skin. (*Actual size.*)

metastases allowed one to sound a slightly more hopeful note.

It was at this stage that further review of the sections showed the pigment to be not melanin but hæmosiderin, and led to an amended report as follows :—

The specimen received (*Fig.* 625) was a piece of skin and subcutaneous tissue measuring 26 × 6·5 cm.; 6 cm. from the lower end was a circular brownish tumour 2 cm. in diameter. It was slightly elevated above the surrounding skin and its superficial surface was quite intact, with no ulceration. The cut surface was 1·2 cm. in depth and had a brownish-red, fleshy appearance; near the surface was a small white solid area. The deep edge of the tumour was not sharply demarcated and beyond it

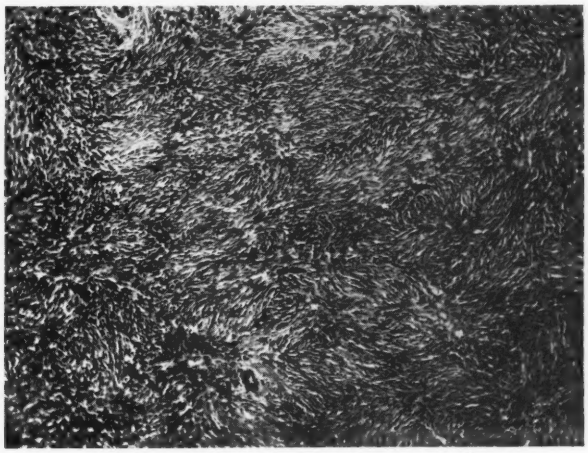


FIG. 627.—*Case* 1. The distinct whorled arrangement of the cells can be seen. (H. E.) (× 37·5.)

was a narrow yellowish zone which was an apparent invasion of the subcutaneous fat.

Three lymph-nodes from above the inguinal ligament and four from below the ligament were sectioned; several of them were pigmented.

Histology (*Fig.* 626).—This is a richly cellular pigmented tumour situated in the dermis. The cells are oval and spindle-shaped; they have a distinctly whorled arrangement giving a characteristic 'étoilé' appearance (*Fig.* 627). Mitotic figures are not seen. There are many large phagocytic cells, some containing pigment

granules and others having a vacuolated cytoplasm. Some multinucleated giant cells are also present. The main mass of the tumour is permeated by fine distorted capillary blood-vessels; towards the periphery they are larger and form wide intercommunicating channels packed with red blood-cells (*Fig.* 628). The basic vascular pattern is well demonstrated by a reticulin stain, which also shows the intercellular framework of delicate reticulin fibrils, many of which are arranged concentrically around the vessels.

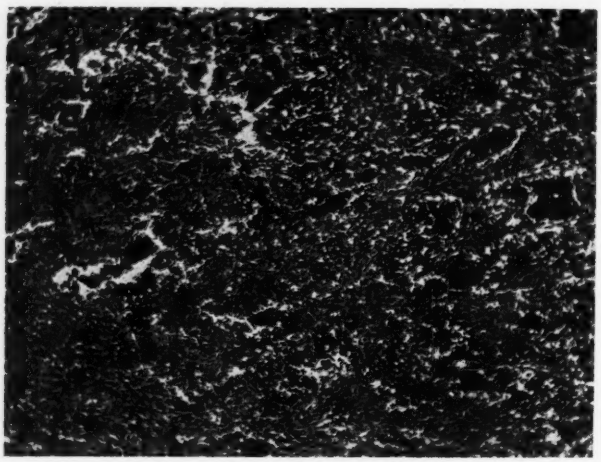


FIG. 628.—*Case* 1. This shows the larger, intercommunicating capillaries situated at the periphery. (H. E.) (× 45.)

Pigment is distributed throughout, both intra- and extra-cellularly, as coarse brown granules. These give a negative reaction for melanin with Masson's silver stain and do not bleach with acid potassium permanganate; Perl's reaction for iron is positive (*Fig.* 629).

The overlying epidermis is atrophic and quite separate from the tumour, although at one edge hair follicles and sweat-glands are being incorporated in the tumour. The lymph-nodes contain pigment in small amounts. This gives the staining reactions for hæmosiderin. There is no evidence of metastatic spread.

DIAGNOSIS.—Sclerosing angioma.

So, having embarked on surgery of the most radical nature, we had now too late established the diagnosis of sclerosing angioma, a tumour which we believe to be perfectly benign and to carry an excellent prognosis. It was good now to be able with assurance to inform the parents of the happy future, but distressing to leave this young woman with a disfiguring scar and a troublesome recurrent œdema of the foot and ankle.

Deeply humiliated by this experience, we were interested to find that our discomfiture had earlier been, in some measure, shared by one of our surgical colleagues.

Case 2.—The patient, again a young woman in her early twenties, first noticed in 1945 a small lump below the lobe of the right ear which grew slowly until it was the size of her index finger-nail. It was said to be hard, but not tender and not inflamed. It was believed to be a sebaceous cyst and was removed (or curetted) under local anæsthesia at another hospital. Nine months later, however, it had recurred and had grown again until it was bigger than before and had become purple in colour. In July, 1947, it was noted during a routine medical examination and she was again referred to hospital, where excision was carried out. At operation the tumour was suspected of being infiltrative in type and it was for this reason, and because of a somewhat disconcerting histological report, that she was referred to the Radiotherapy Department of Hammersmith Hospital in January, 1948. The section of the tumour removed at the most recent operation was reported on provisionally as a malignant melanoma, but further investigation of the staining

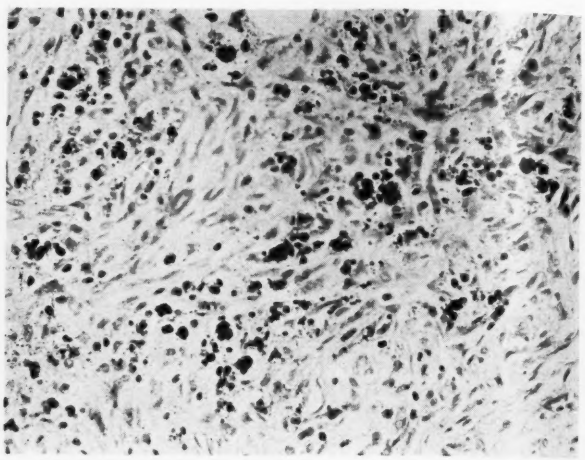


FIG. 629.—*Case* 1. Perl's iron reaction. The pigment gives a positive reaction for iron and is distributed intra- and extra-cellularly. (× 200.)

reactions of the pigment present was put in hand before a firm opinion could be expressed. Unfortunately, before these further tests had been completed, a clinical diagnosis of malignant melanoma had been made and an extensive local resection advised, this to be followed by a block dissection of the neck glands on the same side. The gloomiest of prognoses was given to the parents. A few days later, however, when further sections had been cut and stained, the pigment was shown to be, not melanin, but iron. The diagnosis was changed to that of sclerosing angioma, the report reading as follows:—

HISTOLOGY (*Fig.* 630).—The dermis is involved by a densely cellular non-encapsulated tumour. Most of the cells are spindle-shaped with densely-staining nuclei. Mitotic figures are not present. The cells are closely arranged in small irregular whorls producing a characteristic 'étoilé' appearance. Giant cells of foreign-body type are quite numerous. In some areas, fine hair-like capillaries are seen; a reticulin stain demonstrates these more clearly and also reveals many which are not visible in the H.E. section. They are enclosed in a framework of tightly-packed fine reticulin fibrils with relatively little formed collagen. There are numerous large clumps of brownish-orange pigment granules; these are negative for melanin but give a positive Perl's iron reaction. The epidermis is normal and separate from the tumour.

DIAGNOSIS.—Sclerosing angioma.

The prognosis was correspondingly amended and local excision alone advised, but, disturbed no doubt by this somewhat disconcerting change of front, the girl was taken for further advice elsewhere. Here our revised diagnosis based on the histological section was sustained, and in the course of further examination, three similar but much smaller tumours were discovered—one on the lower aspect of the right buttock, another at the outer side of the buttock, and the third on the front of the left thigh. In addition, there was a small lymph-gland palpable in the right groin. The lumps in the buttock were considered clinically to be benign, but in view of the previous history both the parents and the girl's own family doctor were anxious to have them removed. They proved on section to be lipomata, and the gland, which was excised at the same time, showed only sinus catarrh.

Our last news of this young woman is that sixteen months later she was fit and well, and that there was no suspicion of a recurrence at any site.

It was now only too clearly apparent that the sclerosing angioma can simulate closely, both in its history and in its appearance, that most frightening

FIG. 630.—*Case* 2. This is a densely cellular, unencapsulated tumour occupying the dermis. (H. E.) (× 56.)

of skin tumours, the malignant melanoma. We were left wondering, too, how frequently such tumours following a local or even a wide excision, are, in error, counted in among the ' cures ' in the malignant pigmented skin tumours.

It was for this reason that we were prompted to make further inquiries in an effort to widen our experience. We have since scrutinized, in the files of the Pathology Department, all the skin tumours removed by surgeons over the past fifteen years which were diagnosed clinically as being pigmented. In addition, we have made a diligent search of the clinical records of all patients who were admitted to hospital during the same period and who were indexed as having skin tumours, simple or malignant, whether pigmented or not. We have in this way been able to collect 10 examples of the sclerosing angioma. As seems so often to be the way when one is endeavouring to cultivate an interest in a comparative rarity, several of them have been encountered in the very recent past.

We propose now to present the remainder of this material along with such clinical data as we have available.

Case 3.—Male, aged 71. While in hospital under treatment for hypertensive heart disease, he was found to have a very large brownish tumour on the outer aspect of the left ankle (*Fig.* 631). Starting as a small brownish pimple, it had gradually enlarged over a period of twenty years or more. It had caused little or no discomfort until about six months prior to admission when, following an injury, its surface had been broken and had since discharged a little. The tumour was flattened against the leg, presumably by the pressure of his stocking, so as almost to obscure its very short and relatively narrow anchoring pedicle. Its surface was slightly ulcerated and one had the impression that it was not primarily an epithelial tumour but that it had originated rather more deeply and had stretched its investing layer of epidermis in its outward growth. Accordingly, a provisional

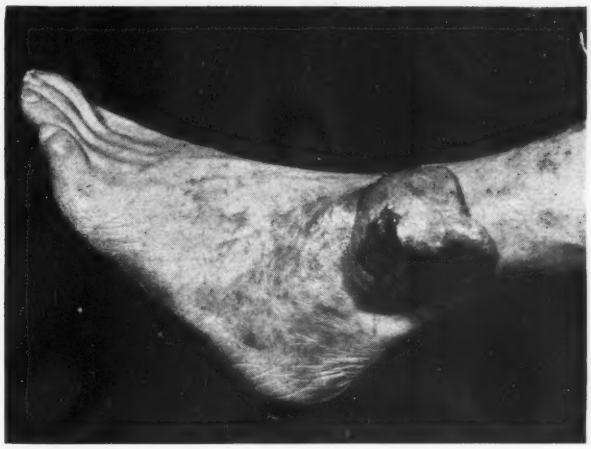


FIG. 631.—*Case* 3. This is an unusually large tumour which was extensively ulcerated. Duration: 20 years.

diagnosis of a simple mesodermal tumour was made—probably a fibroma. In view of its size and because it was a source of some slight inconvenience, it was removed locally along with its stalk down to and including the deep fascia.

PATHOLOGICAL REPORT.—The specimen received was a brownish flattened ' mushroom-like ' tumour measuring 6·5 × 6·0 × 2·0 cm. The overlying skin was intact except for a small L-shaped area showing superficial ulceration. The pedicle was very short and was 2·0 cm. in diameter. The cut surface was firm, and brown in colour, with a few small whitish nodules.

Histology.—The dermis is occupied by a richly cellular pigmented tumour. The cells are oval or spindle-shaped and are dispersed in small, closely packed whorls in relation to very fine capillary blood-vessels. There are a few isolated giant-cells present. The degree of sclerosis varies; in the more cellular parts there are fine reticulin fibrils, but in other areas thick interlacing bands of formed collagen are seen. In the more peripheral areas the capillaries are larger and filled with blood-cells. Silver impregnation, by demonstrating the basement-membrane of innumerable capillaries, and the concentric arrangement of the precollagen fibrils, proves the basic angiomatous pattern. Scattered throughout are clusters of fine, dark-brown granules of pigment, which give the staining reactions for hæmosiderin. The overlying epidermis is in part ulcerated, and where it is still intact there is evidence of slight hyperplasia.

DIAGNOSIS.—Sclerosing angioma.

Case 4.—Male, aged 17. This young man came to hospital in 1943 complaining of a swelling on the back of his right middle finger which his mother believed to be due to " a blow with a hammer when he was a nipper ". It consisted of a brownish pigmented patch, fleshy in

consistence, and slightly raised above the surrounding skin. It involved the major portion of the skin on the dorsum of the proximal phalanx. The patient had noticed that this area seemed to sweat more freely than the rest of his hand, and also that it was rather sensitive to direct pressure. It had never bled. There was nothing relevant in the family history. No enlarged glands could be felt at the elbow or in the axilla and there was no lesion radiologically in the underlying bone. The skin of the arm and all the skin of the trunk was said to show "many pigmented nævi—more than are usually present".

A pre-operative diagnosis of melanoma was made, but at operation this was changed to angioma when many large vessels were encountered during its simple surgical excision. The wound healed satisfactorily.

HISTOLOGY.—In the dermis, and extending into the subcutaneous fatty tissue, is a large amount of dense collagen. Amongst this are some irregularly spaced areas having the structure of a cavernous hæmangioma, while in other parts are residual foci of fine capillaries situated in narrow clefts between collagen fibres. Between the capillaries are a few fusiform cells. Scattered throughout are clumps of coarse, brownish-orange pigment granules. This pigment gives a negative reaction for melanin, and a positive Perl's iron reaction shows it to be hæmosiderin.

DIAGNOSIS.—Sclerosing angioma.

We heard from this young man recently, i.e., seven years after his operation: he is fit and well and there has been no sign of any recurrence of the tumour in the operation site.

Case 5.—Female, aged 44. Early in life she was treated in Riga for what we took to be a tuberculous left hip, which had left her with a short leg on that side.

She came to the dermatological clinic at Hammersmith Hospital in June, 1943, complaining of some slight

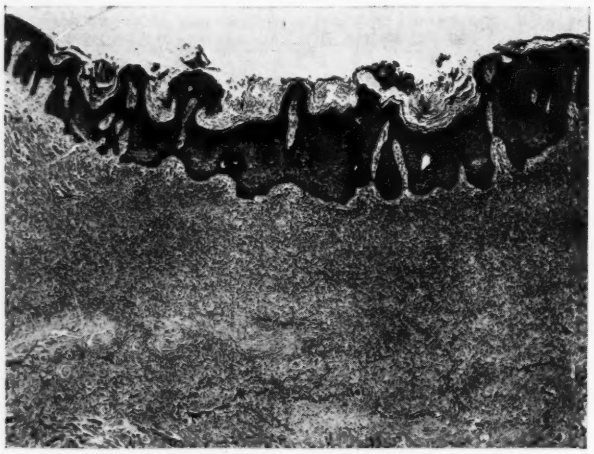


FIG. 632.—*Case* 5. The dermis is occupied by tumour which extends up to the basal layer of the overlying hyperplastic epidermis. (H. E.) (× 6·5.)

discomfort radiating from two pigmented moles on the outer side of the left thigh just above the knee. In addition, she was found to have a lightly pigmented lesion on the right buttock. Each was a little tender and the absence of bluish-black discoloration in either suggested to the dermatologist who first saw her a diagnosis of focal thrombosis or of a papular necrotic tuberculide rather than a melanoma. However, the surgeon to whom she was presently referred accepted this latter diagnosis and arranged for their removal as an out-patient under general anæsthesia, on July 1.

HISTOLOGY (*Fig.* 632).—Both these tumours are of similar structure; they are not encapsulated and are situated in the dermis. Most of the cells are plump and fusiform and are closely aggregated in small, irregularly formed whorls. Amongst the cells very fine capillaries can just be made out lying between and at the centre of the whorls. A reticulin stain shows these more clearly and also demonstrates that each vessel is surrounded by a delicate reticulin framework; farther away from the capillaries the stroma consists of dense collagen. No pigment is present in the tumour itself, but the basal layer of the epidermis contains dark brown granules of melanin. The epidermis immediately overlying the tumour is slightly hyperplastic and hyperkeratotic. A few sweat-glands are enclosed and compressed within the sclerosing process.

DIAGNOSIS.—Sclerosing angioma.

Just over a year later she reported again when she was found to have another and similar lesion measuring 0·6 cm. across and lying flush with the skin, over the lower end of the right tibia. No treatment was, however, advised on this occasion. When last seen in June, 1950, there was no sign of recurrence of the first tumour.

Case 6.—Male, aged 32. This patient, a young surgeon, came seeking the removal of a small nodule which had been present on the dorsum of his left hand for as long as he could remember. Attempts at self removal in his schoolboy days by simple snipping with scissors had been followed by prompt recurrence. The lump was no more than a small firm painless nodule, measuring only a few millimetres across, set in the skin and projecting slightly from its surface. It was dismissed as an innocuous pigmented birth-mark and it was only when the tumour was irritated by repeated 'scrubbing up' and when he became aware of the risk of malignant change in a pre-existing melanoma that he decided to have it removed.

This was carried out under local anæsthesia.

HISTOLOGY.—The dermis is replaced by a mass of dense fibrous tissue, with ill-defined margins, enclosing and compressing a cluster of fine arterioles. Scattered throughout the entire lesion are abundant coarse granules of brown pigment; some of this is found in large phagocytic cells while the rest is extracellular. It has not been possible to determine the nature of the pigment as it gives a negative reaction for melanin, iron, and hæmofucsin. A reticulin stain confirms the presence of the capillaries and shows that between them is a delicate reticulin framework while the rest consists of dense collagen.

DIAGNOSIS.—Sclerosing angioma.

There is evidence already of what looks like a minute recurrence at one end of the operation scar.

The lesions in the next two cases, although obviously pigmented histologically, were not arrestingly so on clinical examination and in neither did the diagnosis of melanoma immediately present itself. However, since each on section shows the typical histological picture, we are describing them both for the sake of completeness and to illustrate how this tumour may not uncommonly appear as a chronic ulcerative skin lesion.

Case 7.—Male, aged 37. This young man came to our surgical out-patient department with a lump in the skin just below the left patella which had been present for at least five years. The covering skin, which previously was intact, had begun to ulcerate only five days before he came for treatment. There was no history of injury and the tumour had caused little inconvenience apart from that associated with the presence of a small discharging wound.

The tumour was found to be a firm, rounded, and flattened plaque set in the skin and tethered by a very wide pedicle only a few millimetres in length. It was surmounted by a dry, brownish crust, but the remainder of the tumour was pinkish in colour. No very definite clinical diagnosis was made, but that of melanoma was in

this case not seriously entertained. The tumour, along with an ellipse of the surrounding skin, was excised under local anæsthesia as an out-patient.

HISTOLOGY.—The dermis is occupied by a mass of vascular fibrous tissue. The degree of cellularity varies, most of the cells being spindle-shaped fibroblasts, separating and distorting fine cleft-like capillaries; over large areas they have a distinctly whorled arrangement. The intercellular connective tissue is abundant. Around the periphery of the tumour the capillary blood-vessels are larger and not distorted by sclerosis. Silver impregnation

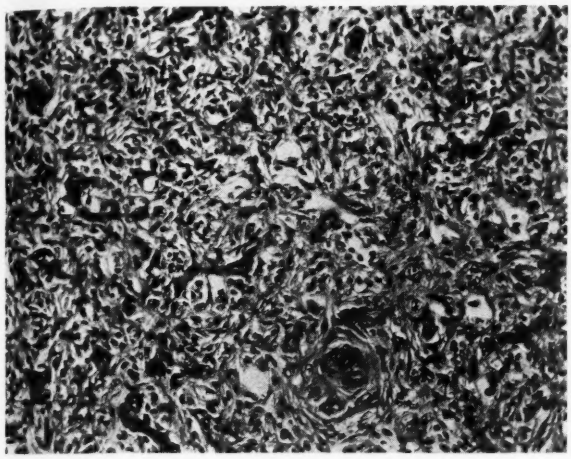


FIG. 633.—*Case* 9. The cells are arranged around and between fine distorted capillary blood-vessels. (H. E.) (× 95.)

brings out the vascular pattern more clearly and shows the interstitial tissue to be composed of well-formed collagen, often disposed in small concentric rings around the capillaries. No pigment is present. Over the summit of the tumour the epidermis has ulcerated; that investing the periphery is slightly hyperplastic and hyperkeratotic.

DIAGNOSIS.—Sclerosing angioma.

Case 8.—Male, aged 35. This young man reported to hospital in May, 1949. He had first noticed a "small spot" on his chin four years before, which had grown a little in size to begin with but had remained more or less stationary for the past two years or so. It had neither bled nor irritated, but recently it had wept a little and some surface crusting had appeared. A clinical diagnosis of rodent ulcer was made at another hospital and he was referred to Hammersmith for radiotherapy.

Just to the right of the midline of his chin was a shallow, irregular ulcer 8 mm. across, with a smooth base and a slightly thickened edge. A fragment of the tumour was taken for biopsy on May 3 and reported on as follows:—

HISTOLOGY.—There is a small, well-circumscribed collection of cells in the dermis. The majority of these cells are spindle-shaped and are arranged in small distinct whorls. A reticulin stain demonstrates the presence of numerous fine capillary vessels which were not detected in the H.E. preparation. No pigment granules are present. The overlying epidermis is hyperplastic and quite separate from the tumour.

DIAGNOSIS.—Sclerosing angioma.

He was given a single application of X rays (2000 r at 120 kv.). A year later he wrote to say that the site of the ulcer still remained firmly healed.

Case 9.—For clinical details of the following case we are indebted to Dr. G. A. C. Lynch, of Torbay Hospital, Torquay.

The patient was a married woman of 56 who gave a history of a lump the size of a golf ball just under the skin in front of the right tibia, which had been present for ten years. The skin over it had recently become ulcerated and this happening was apparently the cause of her coming for treatment. The tumour was removed surgically. The operation was followed by some œdema of the leg and by the appearance of an obvious varicose vein.

HISTOLOGY.—This is a non-encapsulated tumour in the dermis. The degree of cellularity varies, some parts being densely cellular while others are predominantly fibrous. Though some of the cells are large and have clear, vacuolated cytoplasm, the majority are small and

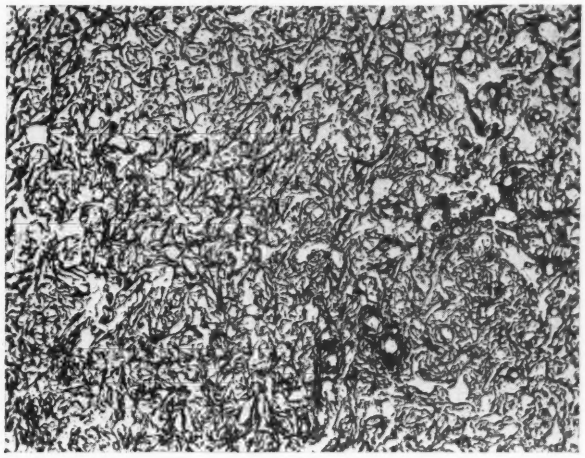


FIG. 634.—*Case* 9. The basic angiomatous pattern is more clearly demonstrated by silver impregnation. (Reticulin.) (× 47·5.)

spindle-shaped. They have a faintly whorled arrangement around and between numerous, narrow, distorted, capillary blood-vessels (*Fig.* 633). A reticulin stain clearly shows the innumerable capillaries and the fine reticulin fibrils arranged concentrically around them (*Fig.* 634). The sharp distinction between the angiomatous pattern of the tumour and the surrounding uninvolved tissue is readily apparent. Though no pigment is visible in a H.E. preparation, Perl's iron reaction reveals the presence of scattered fine particles of hæmosiderin. Part of the overlying epidermis is ulcerated; that remaining is hyperplastic.

DIAGNOSIS.—Sclerosing angioma.

Case 10.—The clinical record of this case is not available. The tumour was removed in the casualty department, the patient being a young married woman in her early thirties.

HISTOLOGY.—The epidermis has ulcerated over the greater part of the surface. The dermis is replaced by a mass of cellular fibrous tissue permeated by numerous large capillaries. The cells are plump and fusiform; in a few areas they are closely aggregated and are in intimate contact with the capillary walls. The intercellular stroma is scanty. Silver impregnation shows clearly the angiomatous nature of the lesion and also the presence of delicate young collagen fibrils. No pigment is present.

DIAGNOSIS.—Sclerosing angioma.

This last case we present with a clinical record alone, as we have been unable to persuade the patient to consent to surgical excision, to confirm what must necessarily remain no more than a tentative diagnosis. It gives us the opportunity, however, of publishing a photograph of what we believe to be a fairly typical example of a sclerosing angioma.

Case 11.—A married woman in her early forties was admitted for the treatment of a carcinoma of the breast.

While she was in hospital it was noticed that she had two lumps on the dorsum of the left hand (*Fig.* 635). These had been present for at least twenty years. Beginning " like marks caused by a black pencil " they had increased in size during the first year or two but had subsequently remained stationary. They had caused no inconvenience whatsoever.

The larger of the two measured only 8 mm. across. It was a circular, sharply demarcated tumour with a slightly raised, rounded, shining surface. It was very firm, and fixed in the skin, and had an intact covering of rather thin epithelium carrying a very few normal hairs.

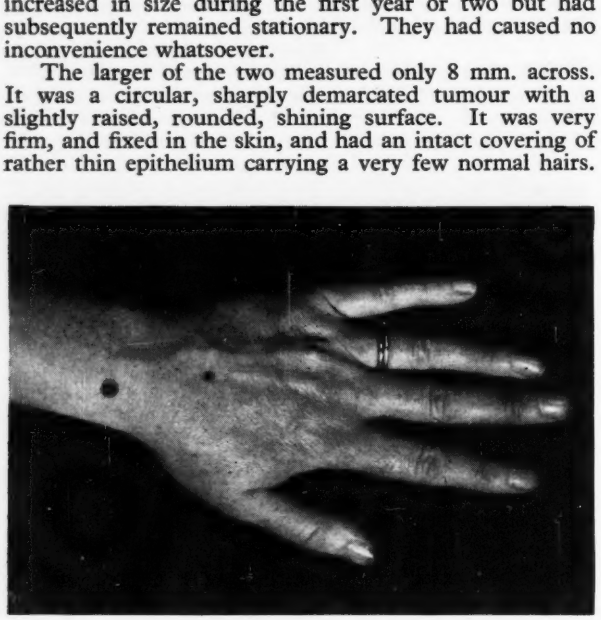


FIG. 635.—*Case* 11. The diagnosis of sclerosing angioma is here based on clinical features alone.

It was quite mobile on the deeper tissues and free from tenderness. Bluish-black in colour, it looked as if it might consist of dilated blood-channels but it could not be obliterated or blanched by pressure.

The second, smaller, and more distal lesion had the same clinical features.

We took the advice of our dermatological consultant in making the diagnosis here and we are glad to find that he unhesitatingly sustained our diagnosis of sclerosing angioma.

CLINICAL FEATURES

Let us now briefly consider some of the clinical features of this interesting skin tumour before going on to discuss some of the problems of its proper management.

Frequency.—We find it difficult to give even an approximate figure for its frequency. We feel fairly certain that it must, in surgical clinics, very often pass by, if not unnoticed, at least unrecognized. From inquiry, however, it is clear that the dermatologist encounters it not infrequently. Rentiers and Montgomery (1949), for example, were able to report a series of 95. Allen (1948), in an analysis of 8000 specimens of skin lesions received by the American Army Institute of Pathology during the war years, came across no fewer than 426 tumours which he classified as sclerosing angiomata. However, even if such figures suggest that the tumour is not uncommon, we are unable to establish just how many of them were clinically pigmented—for this is the group with which we are here primarily concerned. In the paragraphs that follow, the substance of which has been for the most part abstracted from the literature, our remarks must, for the same reason, be taken to apply to sclerosing angiomata in general and not specifically to the pigmented variety.

Our 10 cases (omitting the last, in which the diagnosis was not confirmed histologically) were collected from among 123 clinically pigmented tumours, but this cannot be taken as even an approximate measure of its true incidence, since the pathological material examined was restricted to lesions which were of a size and nature to merit surgical excision.

Age.—The tumour is encountered in the young and in the old, but the age period 30 to 50 is in the experience of most the time of maximum incidence. (Ormsby and Montgomery, 1948; Senear and Caro, 1936.)

Sex.—A striking preponderance in the female sex (5 : 1) was reported by Arnold and Tilden (1943), but this is not a uniform finding and no doubt reflects no more than the greater likelihood of the fair sex coming forward for the treatment of a lesion which is seldom more than mildly disfiguring.

Number of Lesions.—The tumour is typically single, but multiple growths of the same type at widely differing sites are by no means infrequent. (Michelson, 1933.)

Site.—The sclerosing angioma is most often found on the extremities and there is a striking tendency for it to occur in situations where the risk of frequent injury is considerable. This would certainly be a valid reason for the very high incidence on the skin over the front of the tibia. A clear history of a specific, well-remembered injury is, however, the exception rather than the rule. Attributed in some cases to a vague and often trivial blow, in others it has seemed to follow closely in time and exactly in location, a precise injury such as an insect bite or a hypodermic injection (Senear and Caro, 1936).

Pre-existing Lesion.—In a minority of cases there is a clear history that at the site of development of the tumour there had previously been a ' nævus ' —using this term in its widest clinical sense—and that following an injury it has changed both in size and in appearance. Minute vascular malformations in and under the skin must, however, be a commonplace, and the mere fact that no lesion has in most instances previously been noted where a sclerosing angioma ultimately develops, does not, in our view, by any means preclude its having taken origin in a congenital vascular anomaly.

Symptoms.—As a rule, there are no symptoms apart from that of the noted presence of a slowly growing tumour with its attendant disfigurement. On occasion there may be a complaint of itching (as in *Case* 1) and it may, if injured, bleed and weep as well.

Signs.—When first recognized the tumour often measures only a few millimetres across and presents as a firm, rounded, nodule. It slowly increases in size, and when fully developed it usually measures no more than 1 cm. to 1·5 cm. across. By now it is a uniformly firm, well-defined, hemispherical, though somewhat flattened, plaque lying in the skin, but freely moveable on the deeper tissues. Michelson (1933) aptly describes the clinical appearance at this stage as being " just like a hard shot buried superficially in the skin ". It is seldom pedunculated and only rarely grows to any considerable size, in both of which respects our *Case* 3 must be considered somewhat unusual. The tumour is usually raised a

little above the level of the surrounding skin, to which, however, it remains confined with no hint of deeper extension. The skin which forms its surface is commonly smooth, stretched, and often hairless. There may sometimes be slight scaling, but ulceration is unusual. Although typically firm, it may be in part compressible. It is seldom tender—when fully grown the tumour seems for long periods, amounting even to years, to remain unchanged, but a few are said to undergo retrogressive changes and to be represented in the end by no more than a scarcely detectable or even by a slightly depressed scar (Michelson, 1933). As to the frequency of such a happening, we can offer no reliable evidence. The process of involution is accompanied by alteration in the consistency of the tumour, soft compressible areas tending to become increasingly firm, for, as we shall see below, involution is essentially one of increasing fibrosis.

The colour, too, changes considerably at different stages in its growth and the whole range of colour which may be observed in these tumours is a wide one. Early on it tends to be pink (Michelson, 1933), or to have a yellowish tinge, but later it may turn to purple, reddish-brown, or even dark brown or blue-black. It is this variation in colour of the tumour which presents us with some difficulties in the differential diagnosis, and this is especially the case with the varying shades of brown which tend to confront us most often.

Table I.—PIGMENTED PAPILLOMATA. HISTOLOGICALLY PROVEN *

No.	CLINICAL DIAGNOSIS	SIZE	SITE	AGE	SEX	COMMENT
1	Melanoma		Thigh	61	M.	
2	Melanoma		Neck	36	M.	
3	Malignant melanoma	3 × 2 cm.	Forearm	71	M.	30 years' duration: ulcerated and bleeding for 3 weeks
4	Mole		Chest	54	M.	
5	Pigmented wart		Face	45	F.	
6	Melanoma		Pubis	31	M.	
7	Mole	1 × 1·5 cm.	Neck	72	F.	
8	Mole		Abdomen	30	M.	
9	Mole		Abdomen	72	F.	
10	Mole		Forehead	65	F.	
11	Melanoma	1·0 cm.	Forehead	42	F.	1943. Attempted removal
12	Melanoma	0·5 cm.	Forehead	45	F.	1946. Recurrence in scar. Same histology
13	Nævus		Wrist	49	F.	
14	Mole		Buttock	42	F.	
15	Melanoma		Abdomen	40	F.	
16	Mole		Face	42	M.	Increase in size for 3 months
17	Malignant melanoma	1·5 cm.	Forearm	52	F.	Mole all her life, which became larger and ulcerated following an injury 1 year ago: two small moles also appeared nearby
18	Melanoma		Axilla	42	F.	
19	Mole		Chest	65	F.	
20	Mole	1 × 0·5 cm.	Chest	60	M.	Definite increase in size for 6 weeks
21	Mole		Finger	42	F.	
22	Melanoma	1·5 cm.	Chest	72	M.	Many years' duration. Recent ulceration because of irritation
23	Nævus	1·8 cm.	Axilla	35	F.	
24	Mole	1·5 cm.	Abdomen	43	M.	3–4 years' duration. Recent increase in size
25	Malignant melanoma	3 × 2 cm.	Heel	33	M.	Small black ulcerated area
26	Nævus		Chest	60	F.	

* Each of the above 26 skin tumours was proved on section to be a pigmented squamous papilloma. It will be seen that *only one* (*No.* 5) *had been correctly diagnosed clinically.*

MANAGEMENT

1. Diagnosis.—With the non-pigmented tumour we are not, in this discussion, primarily concerned, and we shall content ourselves with noting that it may be mistaken for a xanthoma, the fatty skin tumour of frequent occurrence, or for the more rare cutaneous leiomyoma. Neurofibroma (neurilemmoma), granuloma pyogenicum, and keloid, must also be considered in the differential diagnosis.

When, however, it is pigmented, it may closely resemble in appearance a melanoma and in its behaviour a malignant one. When a young person presents with a history of a birth-mark which, following an injury, has altered in appearance and increased in size, which has ulcerated and bled and is clinically found to be pigmented, little wonder it should be taken for a malignant melanoma. For might not this equally be the opening chapter of the unhappy story which begins with an insignificant malignant melanoma and ends with the widest dissemination of pigmented secondaries? Is not the malignant melanoma equally a tumour of adult life? Does it not most commonly occur on the extremities and especially on the leg, and in the history, are not injury and a pre-existing mole here equally significant? When, as in our first two cases, the tumour has quickly recurred following an attempted removal, the suspicion of malignancy is even more seriously entertained.

How, then, are we to distinguish between these two tumours—(1) the pigmented sclerosing angioma, clinically benign; and (2) the malignant melanoma, that most dread of all primary skin tumours?

Considering this problem in the light of our personal experience and guided, too, by our reading on this subject, *it is our belief that there is no certain way clinically of distinguishing between the two* (*see also* Roussy, Huguenin, and Queyn, 1935).

Perhaps the melanoma is more often ulcerated: perhaps it more often obviously spills its pigment over into the adjoining skin, but features like these are of limited value in helping our decision when we are actually confronted with an individual patient. When the malignant melanoma is ringed by its satellite

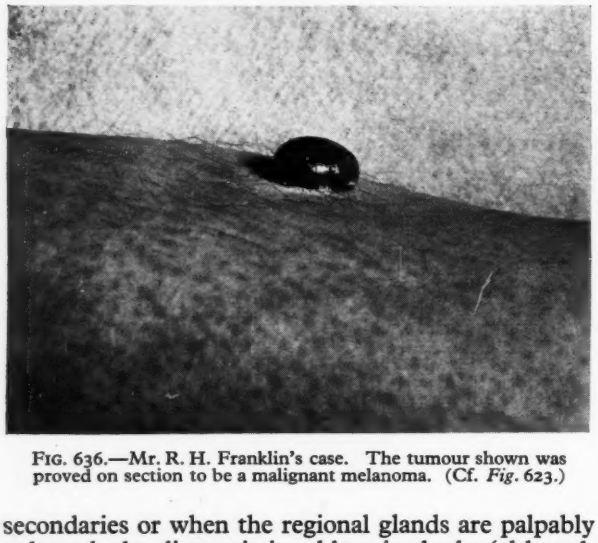


FIG. 636.—Mr. R. H. Franklin's case. The tumour shown was proved on section to be a malignant melanoma. (Cf. *Fig.* 623.)

secondaries or when the regional glands are palpably enlarged, the diagnosis is seldom in doubt (although it is usually already too late to save life), but in the early case it seems to us that there is no way of telling one from the other with certainty—and the decision is such a vital one that any diagnosis short of a certain one cannot seriously be considered.

In this connexion it is also important to point out that certain pigmented papillomata (*Table I*, Nos. 3, 12, 17, and 25) have caused considerable difficulty in diagnosis. Though they had been present for many years, a recent increase in size, ulceration, and even the additional presence of pigmented spots in the immediate vicinity, strongly suggested the diagnosis of malignant melanoma.

The only certain way of establishing the diagnosis is by the most careful histological examination, and even here, as we will indicate below, it is not difficult for the unwary and the uninformed to make mistakes.

Experience has taught us that biopsy of a malignant melanoma is fraught with the very greatest danger of rapid growth and of early and wide dissemination (Tod, 1946). Even a local excision is not without risk: the only safe method is to practice in all cases a wide removal of skin and fascia, keeping at least 4–6 cm. from the margin of the tumour on all sides. If we make this the practice in the management of all pigmented tumours in which the diagnosis of melanoma is being seriously entertained, it is true that in the case which turns out to be a malignant melanoma, a departure from the rational block excision advocated by Hogarth Pringle in 1908 and reiterated and popularized by Pack and Adair in more recent times (1939), may mean that we cut across invaded lymphatic channels running up in the fascia to the regional glands, a practice which offends against the pathologist's conception of the ideal operation in such a case.

In our view, however, this objection is more theoretical than real. Figures leave one in little doubt that when a malignant melanoma has already spread to involve the regional lymph-glands, the prognosis is almost hopeless, and Wright (1949) has recently shown, in his study of the prognosis of the treated malignant melanoma, that by far the most valuable measure in the treatment is the wide local excision.

We believe that the prognosis of the tumour which turns out to be a malignant melanoma, will not be any the worse for having had only a wide local removal, and that this practice will, with a heartening frequency, avoid an unnecessarily severe operation for what turns out later to be a benign lesion.

This is not to suggest that we decry completely the value of wide resection of the regional glands in the management of the malignant melanomata, although we are somewhat sceptical of its value when once they have become involved. What we do believe is that when the diagnosis of malignant melanoma has been established by section of the tumour removed locally but widely (and this by no frozen section, cut and examined in the theatre, but only after a painstaking searching of suitably stained slides), the prognosis is not affected if later it becomes necessary to return to do an excision of the regional glands. Such an excision we would advocate as a routine practice so soon as the pathologist reports, after an interval varying from two to ten days, that the tumour is a malignant melanoma (alternatively some might prefer to follow the precept of Pack, who only does the gland dissection at the end of a long 'filtering' interval of six weeks or so, in the pious hope that any cells disseminated at the time of the first dissection will meantime have been caught up in the regional lymph-glands).

We realize that by suggesting such a practice we are deviating somewhat from orthodox teaching, but we believe that our argument is a good one, as can be illustrated by the following clinical history:—

A young married woman was admitted to hospital under the care of Mr. R. H. Franklin with a small tumour on her left shin. There had been a small, flat brown 'mole' at this site for as long as she could remember, but about two years before it had begun to increase in girth and to become more and more raised above the surrounding skin. Within recent months, too, it had bled and discharged a little.

The tumour present at the time of her admission to hospital is illustrated in *Fig.* 636. Originally brown, it was now said to be mauve in colour. It seemed on palpation to consist of a collection of fluid round a solid core. A provisional diagnosis of malignant melanoma was made, but when one compares this photograph with that of the sclerosing angioma of our first case (*Fig.* 623) the similarity of appearance is very striking and there was an understandable reluctance on clinical evidence alone to proceed to the most radical resection. Accordingly, only a preliminary local removal of the tumour and surrounding skin and underlying fascia was advised. Section,

however, confirmed that the tumour was a malignant melanoma, and on the strength of this diagnosis dissection of the groin glands (they were not involved) was carried out fifteen days after the local excision.

Her luck might so easily have been the other way round, and who can say by doing the operation in two stages rather than in one, that we would have seriously prejudiced her chance of ultimate cure? Will it be argued that we would have been better advised to do a one-stage operation, followed by considerable disfigurement and maybe, too, by disabling œdema, even in the knowledge that the tumour might turn out on section to be a simple sclerosing angioma? Our recent experience strongly suggests that certainly in the case where the diagnosis is in doubt, the two-stage procedure is the one of choice.

2. Treatment.—With the treatment of the non-pigmented case we are not seriously concerned. However, we cannot help feeling that the non-pigmented tumour is better removed, if only to forestall the diagnostic dilemma with which someone later on may well be presented, if perchance the tumour becomes pigmented in the intervening years. In any case, we must admit that a non-pigmented malignant melanoma does sometimes occur.

The pigmented variety is deserving of treatment only in order to establish the diagnosis, for diagnosed it must be with certainty, and it is our contention that only careful histological examination can give this answer, a point which we have, however, already laboured enough. Anything short of wide excision is very dangerous, and cautery, carbon-dioxide snow, X rays, and the like, must not be used under any circumstances. It is true that one of our cases treated by a surface dose of X rays (2000 r) cleared up completely, but the clinical diagnosis had here first been rodent ulcer, and biopsy accordingly had been advised.

3. Prognosis.—The natural history of the untreated disease seems to be one of continuing growth, but at a very slow rate, until it measures 1 cm. across or thereabout, followed by a period of quiescence or even by steady retrogression.

" All are agreed that they are benign "—so writes Purdy Stout (1944) when discussing the sclerosing angiomata, and he speaks with the authority of a wide and critical experience. The tumour, however long-standing, remains confined to the skin and subcutaneous tissue. What some pathologists believe to be a malignant variety has been described—the dermatofibrosarcoma protruberans—but its relationship to the tumour under discussion is by no means clear.

Anderson (1948) maintains that when, rarely, the tumour does recur locally, with the development of apparent satellite nodules, the tumour has probably already extended into the subcutaneous fat and has been incompletely removed. For inadequate removal of this tumour, as of any other, simple or malignant, will be followed by recurrence (or alternatively we are dealing with a tumour which is benign and multicentric, and not malignant and metastasizing—Dawson, 1948). The re-appearance of the tumour in the operation scar seems often to be long delayed, but this latent interval is probably only a measure of the slow growth of neoplasms of this type.

PATHOLOGY

We propose now to pass on to consider some general points in the pathology of this intensely interesting skin tumour.

It was Unna who, in 1896, was the first to describe this tumour, which he called the ' fibroma simplex '. He noted the frequency of preceding trauma. It is interesting to recall that it was his opinion that the tumour originated from an overgrowth of the vascular adventitia, although at the same time he pointed out how difficult it often was to recognize in it the presence of any blood-vessels at all.

The tumour has since been given a considerable amount of attention, for the most part by the dermatologist, during the past twenty years or so, when varying theories of its pathogenesis have been advanced and their varying claims equally vigorously contested. In 1931 Woringer introduced the term ' histiocytoma ', believing the vacuolated phagocytes which are sometimes encountered to be the essential histological feature of the tumour. Michelson (1933), on the other hand, favoured inflammation at the subepidermal level, followed by fibrosis, to be the primary factor. He described 39 cases, and in every one the patient had been referred to hospital because malignancy was suspected. Senear and Caro (1936) reported a group of 25 cases, and they followed Woringer in using the term ' histiocytoma '. Gross and Wolbach (1943) drew attention to the basic angiomatous pattern of the tumour, and suggested that it resulted from progressive sclerosis of a hæmangioma. Dawson (1948), in a detailed study and critical review, also favoured this hypothesis. In a recent paper, Rentiers and Montgomery (1949) concluded that dermatofibroma and histiocytoma are variants of the same condition, the vascularity of the tumour being a secondary manifestation depending on injury and inflammation.

We have observed this angiomatous pattern in every tumour in our series, and the majority of them have been pigmented. Study of this small series strongly inclines us to the view that the sclerosing angioma originates in one of the common, simple, hæmangiomata, which for some reason or other has undergone fibrosis.

Gross Appearance.—The gross appearance may take one of several forms and these have already been described, with the clinical features. The degree of pigmentation, as seen macroscopically on section, may vary, from a light yellowish-brown to a metallic black. Macroscopical examination alone of the cut surface of the pigmented tumour after excision may be of no real help in establishing the diagnosis. This point is well illustrated by the tumours shown in *Figs.* 637 and 625. They were removed from different patients (in each case a young woman) within a short time of each other. The history of the two was not dissimilar, and the tumours were observed clinically to resemble each other remarkably closely. Yet the one proved on histological examination to be a pigmented sclerosing angioma (*Case* 1 of this series), while the other was an undoubted malignant melanoma. With the naked eye no features of value in differentiation can be found on the cut section on the closest scrutiny: indeed, penetration into the subcutaneous tissues appears to be present

in the angioma, while the melanoma has a distinctly more circumscribed outer margin.

Histology. — The histological appearance is varied, and alters in the different stages of development. This has been described and discussed in detail by Dawson (1948) and only the salient features will be summarized here. The tumour, which is well-circumscribed but not encapsulated, is situated in the dermis and it may or may not extend up to the epidermis, which is, however, never actually involved. Sometimes it grows into the subcutaneous

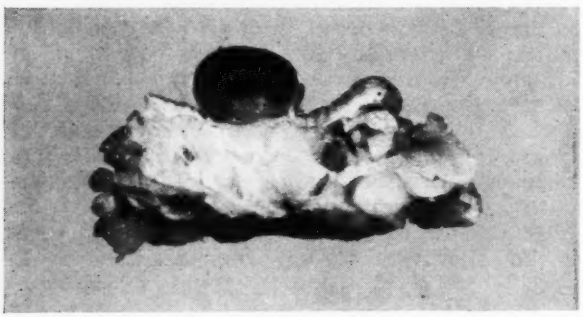


FIG. 637.—Malignant melanoma. Sections of the tumour illustrated in *Fig.* 636. (× 4/5.) (Cf. *Fig.* 625.)

tissues. The majority of cells are spindle-shaped and are arranged in small irregular whorls. Varying numbers of larger, foamy phagocytes may be present. Numerous capillaries permeate the lesion ; they are usually fine, cleft-like, and compressed, and in the main mass of the tumour they are often empty, which allows one to pick out the prominent lining endothelial cells. Towards the periphery the vessels are larger, sometimes forming wide irregular channels packed with red blood-cells.

Reticulin Staining.—Stout (1944) first pointed out the value of the silver reticulin stain in demonstrating the delicate supporting network around capillaries in blood-vessel tumours. Like Dawson, we have been impressed by the great value of this method of staining in the diagnosis of sclerosing angiomas. It brings out clearly the basic vascular pattern and is of particular help in the recognition of the densely cellular tumour which may be readily mistaken for a melanoma or a fibrosarcoma.

Pigment Staining.—Pigment is often found in the form of brownish granules which one is too often tempted to assume to be melanin. It is, however, imperative to establish its exact nature. The presence of melanin must be confirmed or excluded by such methods as Masson's silver stain and by bleaching with acid potassium permanganate. If the pigment gives a positive blue reaction with one of the methods for iron (Perl's iron reaction) it is blood-pigment hæmosiderin and not melanin. It is this reaction which is always positive in the pigmented sclerosing angioma.

The overlying epidermis may be normal, atrophic, or hyperplastic, and in long-standing lesions it is often ulcerated over a varying extent.

Differential Diagnosis.—In the differential diagnosis melanomata, both benign and malignant, must first be considered. The histological pattern alone may be sufficient, but in the more densely cellular and pleomorphic types of sclerosing angiomas, particularly when the surface is ulcerated and when the clinician elicits a history of recurrent growth, the histologist may easily mistake it in an unguarded moment for a malignant melanoma (as was done in the first two of our series). It is in such a case that the use of the reticulin and pigment stains is invaluable, the first to bring out the angiomatous pattern of the sclerosing angioma, the second to determine the nature of the pigment. With a reaction which is uniformly positive for hæmosiderin and negative for melanin, we can confidently exclude melanoma, but *all* the pigment must be blood-pigment, as an ulcerated melanoma may contain blood-pigment as well as melanin.

Neurofibroma and neurilemmoma can usually be differentiated by the presence of 'palisading', though some close, parallel capillaries may produce an appearance resembling this.

A few of our cases, in which the surface was ulcerated, illustrate the point which Dawson (1948) makes—that it may be difficult to distinguish sclerosing angioma from granuloma pyogenicum unless the whole lesion is removed. In such cases there was vascular granulation tissue with numerous fibroblasts just beneath the ulcerated surface, but one could recognize the typical whorled arrangement of the spindle cells around compressed capillaries.

When non-pigmented, the resemblance to fibroma may be very close and the more cellular ones mistaken for fibrosarcomas (Michelson, 1933). Dawson (1950) has come across several examples where the original diagnosis has been fibrosarcoma.

We propose now to present some facts which our review of sections of pigmented skin tumours has brought to light—findings which have to us been somewhat surprising and which we believe to be not without considerable practical significance to the clinician ; and indeed our colleagues in the Pathology Department were equally surprised at the figures presented in this analysis.

Points revealed by Histological Examination of Pigmented Tumours.—Sections of all the clinically pigmented tumours which have been excised by the surgical staff during the past fifteen years (and that for a variety of reasons) have been re-examined by one of us and the pathological diagnosis checked independently by members of the Pathology Department. A mixed bag of 123 tumours was collected: they have been classified and analysed as set out in *Tables II* and *III*. As they have been seen and treated by surgeons working in a general hospital, with no selection, it may be assumed that they are probably representative of the type and proportion of such tumours which are referred for surgical treatment.

It can be seen that the tumours fall into one of three main groups, depending on the type of pigment present and its situation in the skin (*Table IV*). In the first two the pigment is melanin, which in one is confined to the epidermis alone while in the other, the true melanoma, it is diffusely scattered in addition in the adjoining dermis.

It is with the third group which comprises these lesions where hæmosiderin and not melanin is the responsible pigment, that we have been so far mainly concerned. We will content ourselves, in passing, with pointing out that the diagnosis of sclerosing

angioma was made clinically in no single instance, although it was found on histological examination to comprise no less than 8 per cent of the total. It is a little surprising, too, and heartening, to discover that no sclerosing angioma has gone for long masquerading as a melanoma, so that at least one has the satisfaction of knowing that we are not including any of them in our ' cures ' in the malignant melanoma group.

Table II.—Clinical and Pathological Diagnoses (123 *Clinically Pigmented Tumours*)

The Clinical diagnosis was :—

		No.	Per Cent
1. Melanoma :	Malignant Doubtful malignant	28	22·9
2. Melanoma :	Simple (mole, hairy mole, nævus)	74	60·3
3. Pigmented wart or papilloma		12	9·8
4. Unspecified pigmented skin tumour		9	7·3

The Pathological diagnosis was :—

			No.	Per Cent
1. Melanoma :	Malignant	16	19	15·4
	Doubtful malignant	3		
2. Melanoma :	Simple	48	51	41·5
	Blue nævus (melanophoroma)	3		
3. Pigmented epithelial tumours :				
	Squamous papilloma	26	30	24·3
	Basal-cell carcinoma	4		
4. Angioma :	Capillary hæmangioma	5	15	12·1
	Sclerosing angioma	10		
5. Others :	Squamous carcinoma (non-pigmented)	2	8	6·7
	Neurofibroma	2		
	Sweat-gland tumour	2		
	Hæmatoma	2		

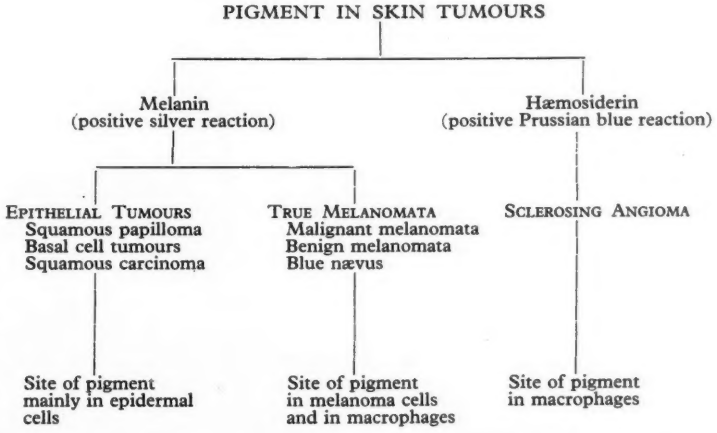
The benign melanomata form, as one might expect, the biggest single subdivision in the whole series. The features, clinical and pathological, of the melanomata in general are well known, and we will not enlarge on either of them. It is interesting, however, to note that the percentage of cases placed by the clinician both in the malignant and in the simple melanoma group, was later found by the pathologist to be unduly high, the first no doubt because the surgeon was fearful of overlooking malignant disease, and the second because he included in this group many of the pigmented tumours which we shall consider in the succeeding paragraphs.

In a symposium on malignant melanomata held in 1945, Bonser (1946) stated that the pigmented epithelial tumours were not sufficiently recognized by pathologists (a deficiency, however, which the work of Stewart and Bonser (1948) and Lennox (1949) must have gone far to make good) : it would, however, seem to us equally true that with their existence the clinician is no more familiar. We have in *Table I* set out, as far as we were able, some of the details of this group. Although it is apparent that most of the patients are over 40, there is a small number in the thirties. This is the tumour which goes correctly under the title ' hard mole ' or ' verruca senilis', but examination of the clinical diagnosis in our series shows that this was in no single instance wholly correct. No less than 22 of a group of 74

Table III.—Comparison of Clinical and Pathological Diagnoses

Clinical Diagnosis	Pathological Diagnosis
1. Malignant (or ? malignant) melanoma 28	14 Malignant melanoma 3 Doubtful malignant 2 Simple melanoma 1 Blue nævus (melanophoroma) 3 Pigmented squamous papilloma 2 Squamous carcinoma 1 Capillary hæmangioma 2 Sclerosing angioma
2. Simple melanoma Mole Hairy mole Nævus 74	2 Malignant melanoma 34 Simple melanoma 1 Blue nævus (melanophoroma) 22 Pigmented squamous papilloma 3 Basal-cell carcinoma 3 Cavernous hæmangioma 3 Sclerosing angioma 2 Sweat-gland tumour 2 Neurofibroma 2 Hæmatoma
3. Pigmented wart or papilloma 12	8 Simple melanoma 1 Pigmented squamous papilloma 1 Basal-cell carcinoma 1 Capillary hæmangioma 1 Sclerosing angioma
4. Unspecified pigmented skin tumours 9	4 Simple melanomas 1 Blue nævus (melanophoroma) 4 Sclerosing angioma

Table IV.—Classification of Pigment Tumours



tumours variously diagnosed as simple melanoma, mole, and the like, turned out on section to be simple pigmented papillomata.

It is interesting, too, to note that almost a quarter of the patients were senior members of the medical staff or their relatives. The history in such cases was usually that of a pigmented mole which had been present for many years, but which because of a recent increase in size or of ulceration following chronic irritation was now proving to be a source of considerable anxiety.

SUMMARY

The sclerosing angioma is a not uncommon pigmented skin tumour. The clinical records of 11 examples are presented. It may simulate very closely in its history and its appearance a malignant melanoma, and with this it is often confused. An inaccurate histological diagnosis may also be made if steps are not taken to establish the nature of the hæmosiderin pigment by iron stains. In the surgical management of any pigmented skin tumour which cannot be diagnosed with certainty by clinical methods alone, the first step should be in every case a wide local excision, to be followed later by a dissection of the regional glands only when a diagnosis of malignancy has been upheld.

Review of sections of 123 clinically pigmented skin tumours revealed a high proportion of mistaken diagnoses. A significantly large number of the pigmented skin tumours were epithelial in origin, simple and malignant: the sclerosing angiomata were found to compose a surprisingly high percentage of the entire group (8 per cent).

We acknowledge with gratitude the help which we have received in the preparation of this paper from many of our colleagues, both surgical and pathological. Our thanks are especially due to Dr. C. V. Harrison, Dr. I. Doniach, and Dr. B. Lennox, in the Department of Pathology. Sections are the work of Mr. J. G. Griffin and his staff, and the photography that of Mr. C. V. Willmott.

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THE ANATOMY OF AN OBLIQUE PROXIMAL SEPTUM OF THE PULP SPACE

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THE importance of the anatomy of the hand in relation to infection is reflected in the extent of the literature that has accumulated around this subject. A review of this, however, rarely reveals evidence of detailed study of the anatomy of the pulp space, and there is no precise delineation of the disposition of structures in the proximal part of this space.

Kanavel (1939) notes that " The connective tissue framework is such as to produce a closed sac comprising the distal part of the phalanx, thus differing from the remainder of the finger ". Handfield-Jones (1946) states that " . . . the deep fascia is adherent to the skin at the distal flexion crease opposite the distal interphalangeal joint ". Schreiber's excellent article on the connective tissue of the finger (1942), whilst showing that at the distal flexure crease the volar tissues are definitely closer together, does not disclose their nature and disposition. Bunnell (1948), in describing the finger, writes: " The distal segment is divided by a fibrous, oblique diaphragm. The pulp space, including the distal third of the diaphysis is anterior to it, and the epiphysis, proximal two-thirds of the diaphysis, and nail posterior ". There is no diagram to explain this rather confusing statement.

References to the subject in other books and articles are equally indefinite, so it was decided to re-investigate the pulp space, and particularly the arrangement of tissues in the proximal part. The results of the examination of sixty fingers by various procedures will here be described.

METHODS OF INVESTIGATION

1. Dissection.

2. Study of coronal, sagittal, transverse, and oblique sections. These sections, 100 μ in thickness, were cut with a freezing microtome and subsequently stained by Verhoeff or Verhoeff-van Gieson techniques.

3. Injection of the pulp space under controlled temperature and pressure : (*a*) with gelatin-carmine followed by section ; and (*b*) with silver iodide, the results being studied by fluoroscopy and recorded on serial radiographs.

4. Examination of the precise relationships of the termination of the synovial tendon-sheath. This was done radiographically, the sheath being filled with colloidal silver iodide by centrifugal force.

INVESTIGATION

On dissection, the increased density of fascia at the distal volar crease level becomes evident as the skin is reflected, but accurate demonstration of its nature and attachments is difficult by dissection alone. Examination of sections proved more informative.

The centre of the pulp space comprises areolar tissue, loosely loculated by irregular fibrous trabeculæ. The fascia immediately deep to the skin of the distal volar crease contains fibres which cross obliquely to the long axis of the finger (*Fig.* 638). In close apposition to the ventral aspect of the terminal phalanx and tendon insertion there is a longitudinal midline concentration of dense connective tissue (*Fig.* 639). This is part of the true deep fascia of the pulp space. On this plane there are vessels and nerves lateral to the tendon and little apparent condensation of tissue to interrupt continuity between the areolar tissue in the pulp space and in the volar region of the middle phalanx. In contrast to this, more dorsal coronal sections through bones reveal an absence of fat loculation on either side of the distal interphalangeal joint, connective tissue bundles being seen in this position (*Fig.* 640). Coronal sections therefore demonstrate that, whereas there is a little areolar tissue alongside the palmar digital vessels

FIG. 638.—Coronal section of a finger showing irregular fat loculation in the centre of the pulp space and collagenous bundles crossing obliquely deep to the distal flexure crease. (Verhoeff.) (× 3·6.)

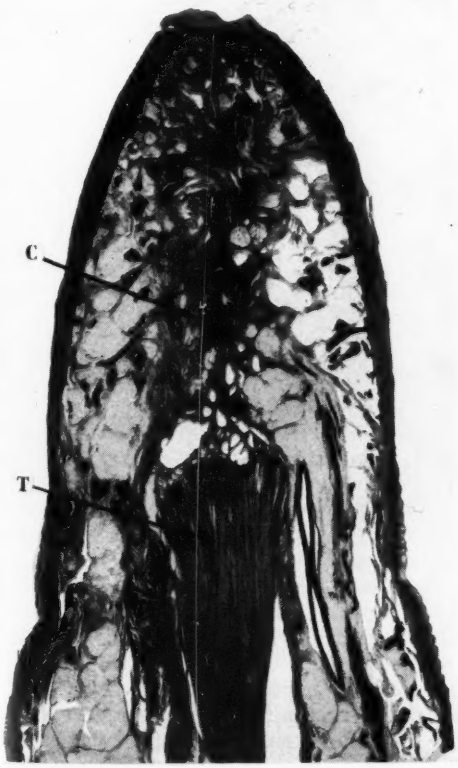
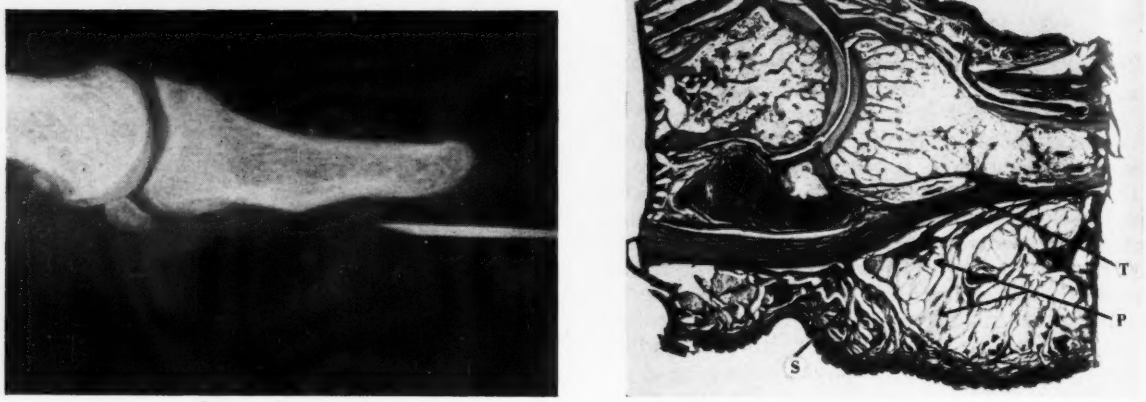


FIG. 639.—Coronal section of a finger. C, Deep fascia ventral to the terminal phalanx. T, Tendon of flexor digitorum profundus. (Verhoeff.) (× 3·6.)

FIG. 640.—Coronal section through the terminal phalanx. There is no fat loculation lateral to the interphalangeal joint. (Verhoeff.) (× 3·6.)

and nerves, there is dense connective tissue both dorsal and ventral to them at the distal volar crease. This connective tissue, ventral to the vessels and nerves, is continuous with similar tissue ventral to the tendon at this level.

Sagittal sections (*Figs.* 641, 642) illustrate that between the tendon-sheath and skin at the distal flexure crease there is a well-demarcated aggregation



A B

FIG. 641.—A, Lateral radiograph of a thumb, into which air has been injected (× 2); B, A sagittal section of a thumb (Verhoeff) (× 2·8). Note the relative disposition of the pulp space (P), the flexor pollicis longus tendon (T), and the connective tissue (S) deep to the distal volar crease.

of connective tissue attached to the tendon-sheath dorsally and continuous superficially with the fascia immediately deep to the skin. Situated between more

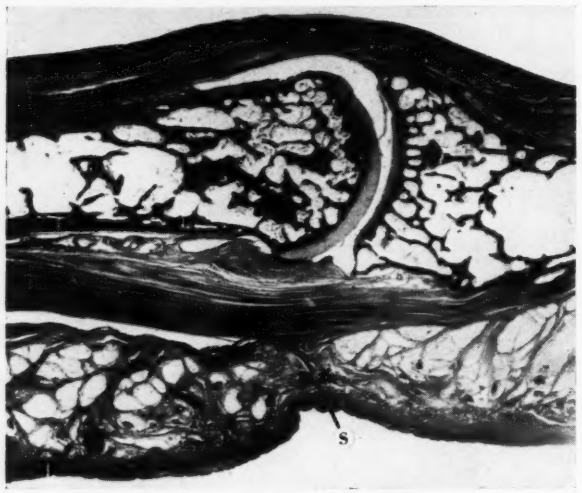


FIG. 642.—Sagittal section of a forefinger through the distal interphalangeal joint. There is an aggregation of connective tissue (S) between the distal volar crease and the tendon sheath. (Verhoeff-van Gieson.) (× 3·6.)

lightly stained areolar tissue proximally and distally, its general direction is oblique, and it is concentrated at, and to a variable extent distal to, the skin crease. This is evidently a point where fibres of superficial and deep fascia intermingle and it exemplifies the statement of Wood Jones (1944) that "At flexure lines the superficial and deep fascia are blended, and the skin becomes more or less anchored to the deeper tissues". It is here interesting to note that in *Galago moholi* and in *Tarsius spectrum*, the flexor profundus digitorum and flexor pollicis longus tendons give off skin extensions to the crease at precisely this level.

Sagittal sections also demonstrate that in Man the insertions of the flexor digitorum profundus and flexor pollicis longus extend beyond the base of the phalanx. The insertion of flexor pollicis longus creates a ridge on the ventral aspect of the *shaft* of the terminal phalanx, well seen in lateral radiographs (*Fig.* 641). Indeed, on dissection some tendinous fibres of the flexor pollicis longus may be traced as

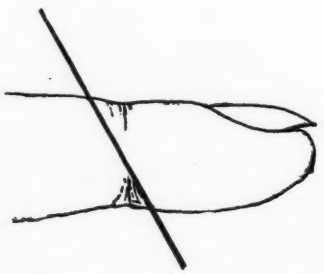


FIG. 643.—Diagram to show the approximate angle at which the oblique sections were cut.

far as the base of the tuberositas unguicularis (the expanded distal extremity of the terminal phalanx). A comparison between a radiograph of a thumb (*Fig.* 641) into which air has been injected and a sagittal section of a thumb illustrates the relationship between the pulp space, tendon insertion, and the connective tissue of the flexure crease.

The existence of a septal arrangement of connective tissue at the level of the distal volar crease is thus suggested by coronal and sagittal sections. However, as this septum is disposed obliquely, it is demonstrated less well in transverse sections than in oblique sections taken at an angle of approximately 60° (*Fig.* 643). *Figs.* 644, 645 illustrate two such sections, taken through the joint cavity, an articular surface being present on the ventral aspect of the

bone. Skin ligaments, originally described by Cleland (1878), pass laterally from the joint capsule to the skin. The profundus digitorum tendon is here, but in its place there is a dense septal sheet of connective tissue, perforated on either side, ventro-lateral to the tendon, by a well-defined neurovascular

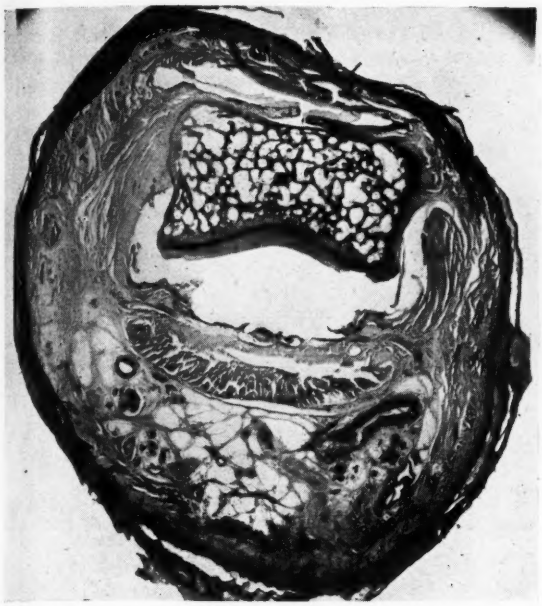


FIG. 644.—Oblique section through the distal interphalangeal joint of a finger showing fat loculation ventral to the flexor tendon. (Verhoeff.) (× 3·6.)

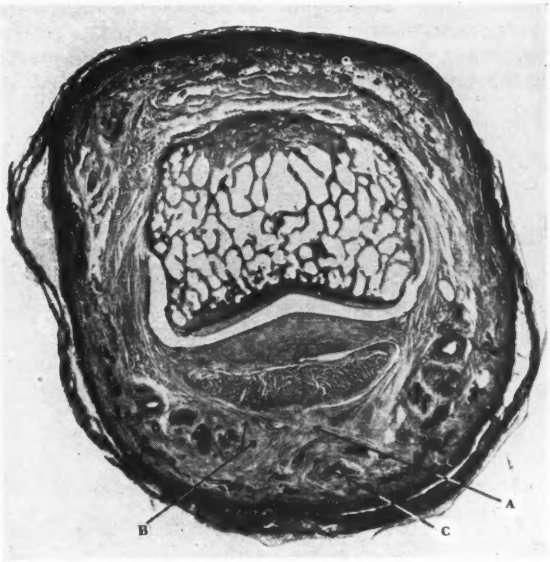


FIG. 645.—Oblique section slightly proximal to that shown in *Fig.* 644. This illustrates a septal arrangement of connective tissue between the flexor tendon-sheath and the distal volar crease. A, Central decussating bundles of collagen; B, Lateral fibres curve around a neurovascular bundle maintaining the side of the finger from which they originate; C, Midline subcutaneous vein. (Verhoeff.) (× 3·3.)

FIG. 646.—Oblique section of a finger immediately proximal to the distal flexure crease. (Verhoeff.) (× 4.)

FIG. 647.—Oblique section taken through the shaft of the middle phalanx of a finger. (Verhoeff.) (× 4.)

not divided longitudinally (as in more proximal sections), but is flattened as it passes over the joint to its insertion. In the first section (*Fig.* 644) there is loose areolar tissue ventral to the tendon-sheath. In sharp contrast, the second section (*Fig.* 645), which is more proximal, shows no fat loculation bundle. Incidentally, venæ comitantes are minute and occasionally absent at this level, but a comparatively large midline subcutaneous vein is commonly present; sometimes there are two subcutaneous veins in this position. The criss-cross arrangement of the central fibres of the septum is noteworthy,

the more lateral fibres maintaining the side of the finger from which they originate, an arrangement curiously reminiscent of the disposition of the nerve-fibres in the optic chiasma. The septal fibres consist almost entirely of bundles of collagen, with interspersed elastic fibres. More proximal sections (*Figs.* 646, 647) show only a few decussating collagenous bundles ventral to the tendon-sheath. The tendon is partially divided by a midline cleft and loculated fat is present ventral to the tendon-sheath.

At the level of the middle flexure crease, relatively sparse connective-tissue fibres, often possessing a hyoid arrangement and straddling large subcutaneous veins, extend between the tendon-sheath and the skin, but no true septum has been demonstrated here. Preliminary studies on toes have not so far revealed the existence of a septum comparable to that found in fingers, but this work is not yet completed.

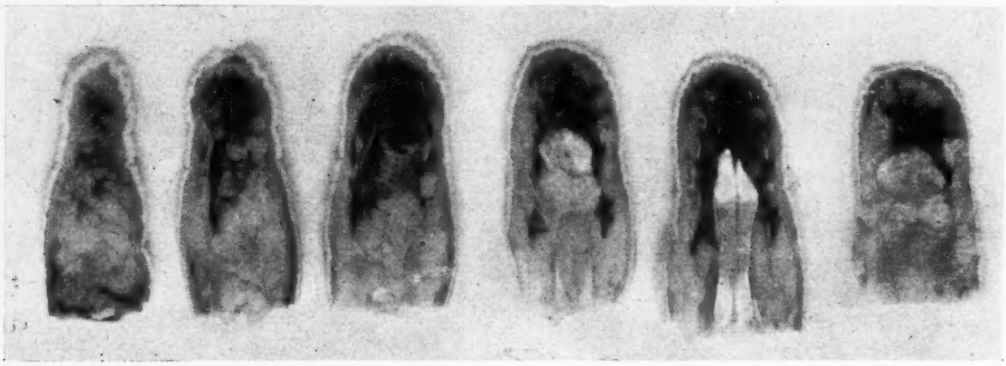


FIG. 648.—Serial coronal sections of a finger, the pulp space having been injected with gelatin-carmine.

Injection Experiments.—Investigation of the relation between the oblique septum described above and fluids injected into the pulp space was undertaken. The temperature was maintained at 37–39° C. by means of a water bath, and pressure was controlled by a mercury manometer.

As serial coronal sections show (*Fig.* 648), it was found that a gelatin-carmine injection mass filled the pulp space and began to flow proximally alongside the neurovascular bundles into the middle phalangeal volar space at pressures between 150 and 200 mm. Hg, the pressure being maintained for half an hour.

Colloidal silver iodide was injected into the pulp space at a pressure of 150 mm. Hg for 15 minutes (*Fig.* 649) and then the pressure was raised to 200 mm. Hg for 10 minutes (*Fig.* 650). A slender proximal prolongation of the injection mass is seen to correspond in position to a neurovascular bundle.

These experiments are not meant to illustrate the spread of pus. A few direct measurements of the pressure created by an accumulation of pus in pulp-space infections gave much lower figures than the experimental injection pressures used. Inevitable autolytic changes in the fat of even well-preserved cadavers facilitate the spread of fluids injected into the pulp space. Thus the finger of a patient who had died 12 hours previously was injected at a pressure of 200 mm. Hg for 2 hours and the filling of the pulp space was less extensive than in the finger illustrated in *Fig.* 650. The injection experiments described above do demonstrate, however, the presence of a definite proximal barrier to the spread of the injected fluids which was penetrated only alongside the neurovascular bundles.

FIG. 649.—Pulp space injected with silver iodide at a pressure of 150 mm. Hg.

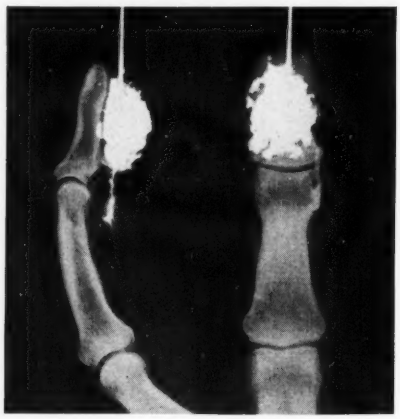


FIG. 650.—Pulp space injected with silver iodide at a pressure of 200 mm. Hg.

The relations of synovial sheath to septum and pulp space were also investigated. The close approximation of visceral and parietal layers creates difficulty in clear delineation by ordinary injection methods. Colloidal silver iodide was therefore introduced into the synovial tendon-sheath at the base of an amputated finger. This was centrifuged and the process repeated until particles of the suspension were forced to the distal extremity of the lumen of the sheath (*Fig.* 651). In five fingers it was noted that the cavity of the sheath terminated immediately distal to the position of the proximal septum of the pulp space and did not extend quite as far as the insertion of the flexor profundus digitorum tendon. A slight constriction was observed at the junction of the sheath and septum. The relationship between the distal part of the lumen of the synovial sheath and pulp space is demonstrated in the last figure (*Fig.* 652).

FIG. 651.—Synovial flexor tendon-sheath outlined with silver iodide. Arrows indicate a constriction at the level of the distal volar crease.

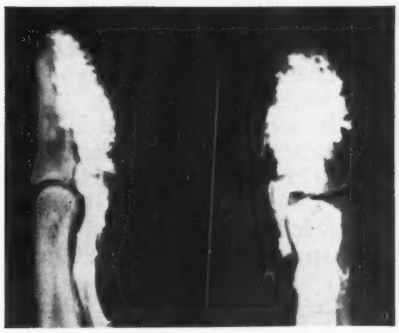


FIG. 652.—The synovial sheath and pulp space, injected separately with silver iodide.

CONCLUSIONS

An oblique septum exists in the proximal part of the pulp space of the finger and thumb. It extends from the fascia immediately deep to the skin of the distal volar crease to the fibrous and synovial tendon-sheaths. It extends laterally from these sheaths and the joint capsule to blend with Cleland's ligaments and so reaches the skin. The fibres of this septum invest the neurovascular bundles on each side and a large midline subcutaneous vein or veins. Superficial and deep fascial fibres blend together in its formation and a clue to its nature may be provided by the fact that in certain primates some fibres of the flexor profundus digitorum extend ventrally to be inserted into the skin opposite the distal flexure crease.

The septum probably accounts for the linear nature of the distal volar crease as compared with the broader middle crease.

In pulp-space infection the well-known danger of prolonging hockey-stick incisions to the level of the distal crease is emphasized, for even if the synovial sheath escapes injury a potential barrier may be destroyed and infection introduced into the tissues ventral to the middle phalanx.

I wish to thank Professor G. A. G. Mitchell for his kind encouragement and advice in the preparation of this paper; Professor F. Wood Jones, who generously made available certain primate hands for examination; Mr. H. Gooding and Mr. C. K. Pearson for the preparation of sections; and Mr. F. L. Newell, the radiographer, and Mr. P. Howarth, the photographer to the University Anatomy Department. The Medical Research Council has partially defrayed expenses involved in this study.

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THE ECTOPIC URETER IN CHILDHOOD
WITH AN ACCOUNT OF FOUR PERSONAL CASES

By A. J. ALLDRED and T. T. HIGGINS, London

The ectopic ureter is a rare anomaly. Fraser (1938) suggested an approximate incidence of 1 : 130,000 persons. Yet in all, only some 300 cases seem to have been reported. Clearly many must have been unrecorded and no doubt many have gone unrecognized. The *incidence* is far higher in females, incontinence leading to diagnosis. In the male incontinence is not a feature and the diagnosis is likely to be made only when infection is present. Eight cases only have been diagnosed in males during life (Meredith Campbell, 1937). It is possible that the anomaly is, in reality, less rare in boys than this would suggest and that some cases of obscure enuresis may have such an explanation.

The 4 cases here recorded have been met with in the Urological service of the Hospital for Sick Children, Great Ormond Street, over a comparatively short period. All had been treated for varying times for ' enuresis ' and urinary infection until adequately investigated. They suggest that the ectopic ureter might be more frequently recognized in early life than it is. The account of these cases serves to illustrate the difficulties of diagnosis and to indicate that they are not insuperable. We would particularly stress the significance of the ectopic ureter in relation to ' enuresis ' in childhood, a disorder which continues to be managed very largely on empirical and unscientific lines.

Site of the Opening.—In the male an ectopic orifice may occur anywhere between the site of the normal ureteric openings and the verumontanum. It may very rarely be in the derivatives of the Wolffian duct such as the vas deferens or the seminal vesicles.

In the female the common sites are in the urethra, the vestibule, and the vagina. Openings have also been reported in the uterus, cervix, and rectum.

All the cases in this series had openings in the vestibule or lower urethral lip visible to the naked eye.

Embryology.—This has been fully reviewed by Scott (1944). The normal ureter develops as an outgrowth from the Wolffian duct and passes dorsally to meet the metanephros, ultimately forming the conducting system of the kidney. The lower end of the Wolffian duct and its ureteric bud become absorbed into the primitive bladder, and it is believed that the muscle of the trigone and the upper part of the urethra are derived from Wolffian tissue. This process of absorption followed by growth changes is clearly seen in the male, where the definitive ureters and the Wolffian ducts, represented by the ejaculatory ducts, are separated by the trigone and prostatic urethra. In the female the picture is complicated by the regression of the Wolffian ducts and the persistence of the Müllerian ducts to form the genital tract. The ureteric bud may be duplicated—a comparatively common anomaly. In rare instances triplication is seen, as in T. T. Higgins' case, reported by Irvine Smith (1946). Fission proceeds from above downwards and varies in degree. In the incomplete type, the two ureters fuse at some point above the bladder and the single vesical orifice is communal. In the complete type the two ureters present two separate bladder openings. In such cases the lower and medial orifice communicates with the upper renal segment. The best explanation of this has been suggested by Johnson (quoted by Meredith Campbell), namely, that the primary bud to the upper kidney retains its association with the Wolffian duct and travels down with it, crossing its fellow ureter and coming to terminate at a lower level.

If differences in the site of budding and the amount of Wolffian tissue absorbed into the bladder are assumed, it is not difficult to see how ectopic openings may come to lie at any point between the upper angles of the trigone and the verumontanum or even in the ejaculatory duct or seminal vesicle in the male, and in the bladder, urethra, and vestibule in the female. There appears to be no satisfactory explanation of openings into the upper part of the female genital system or rectum. The many embryological possibilities have been listed by Kilbane (1926). Any kidney, whether normal or abnormal in position or structure, may have a ureter ending in an abnormal site, but the common malformation is a double ureter with the abnormal orifice communicating with the upper portion of the kidney. Green and Ferris (1942) report 2 cases in which the duplication and abnormal orifices were bilateral. In *Case* 4 of the present series, the anomaly was bilateral.

Symptoms.—Most cases present as incontinence or infection. In males, only infection is likely to lead to diagnosis. In females, the commonest symptom is incontinence, present from birth, but this is by no means a constant feature. Incontinence may be absent as in *Case* 3, or ' postural ' as in *Cases* 1, 2, and 4 of this series. The postural type of incontinence is remarkable ; in spite of the passage or urine at normal intervals, the child is constantly wet by day when ambulant, but remains perfectly dry by night or when lying down for any length of time. Incontinence of this type is almost pathognomonic of an ectopic ureter.

Infection with acute flaring attacks or chronic pyuria may well supervene to complicate the clinical picture and may be manifested in bizarre fashion as in *Case* 3, where the child passed alternately specimens of clear and turbid urine.

These clinical features are explained by the fact that the ectopic ureter is prone to dilatation and therefore to infection. It is commonly found as a large tortuous sac-like channel surmounted by a small portion of kidney in varying stages of degenerative dilatation. Such a ureter acts as an elongated bladder, storing urine while the patient is horizontal and allowing leakage due to hydrostatic pressure as soon as the vertical position is assumed. The child ' wets the bed ' only if sitting up.

Diagnosis.—Incontinence of the type described should always suggest very strongly the presence of

an ectopic ureter. Superadded infection may confuse the picture, but the significance of an accurate history needs no further emphasis.

The investigation begins with a careful inspection of the vulva, urethral orifice, and vagina. This requires a good light and considerable patience. Extreme gentleness to prevent discomfort will allow a thorough examination without anæsthetic, which is preferable in the first instance. Urine may be seen trickling from the vestibule, but it may take a careful search to locate its exact origin. Where there is

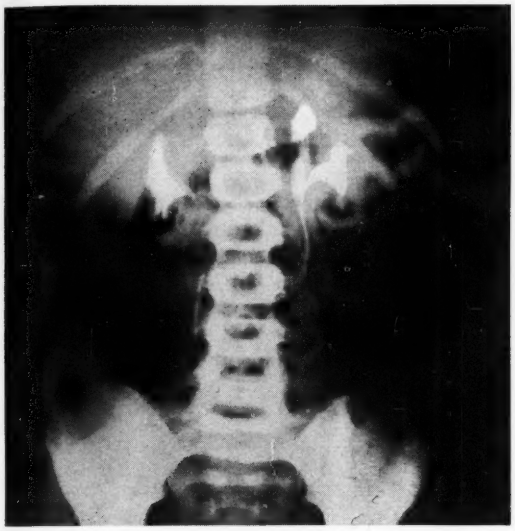

FIG. 653.—*Case* 1. Intravenous pyelogram, 20-min. film, showing double kidney and ureter on left side.

doubt a small piece of wool smeared with petroleum jelly is tucked into the vagina and another into the urethra, thus excluding both as the source.

Characteristically the ureteric orifice is slit-like and lies just alongside, behind, or within the urethral meatus. Many small pits exist in the normal vestibule and are easily mistaken for an ectopic opening, particularly if the efflux of urine runs over them. The true orifice is seen to open and efflux, or can be persuaded to do so by suprapubic pressure. Indigo-carmine injected into the bladder, followed by the wearing of a vulval pad for an hour with the patient ambulant and avoiding micturition, will exclude the bladder as the source of the incontinence. Indigo-carmine injected intravenously may be seen to efflux from the abnormal opening and may stain a swab blue, but a delay of some hours may well elapse owing to the poor function of the associated renal segment, and this test has not helped in our cases for this reason. Where the opening is into the vagina, an examination under anæsthetic is necessary, and this should be done in all cases as a preliminary to cystoscopy.

If an ectopic orifice is found and a ureteric catheter can be passed through it, the ureterogram affords dramatic confirmation of the diagnosis (*see Cases* 3 and 4). But this may be impossible, as in *Cases* 1 and 2, where the opening was too small and the channel too tortuous to admit the smallest probe. In such circumstances excretion pyelography becomes of supreme diagnostic importance (*see Figs.* 653, 655, 663). The pyelograms will serve to outline a double kidney and ureter, or at least to suggest the anomaly from distortion of the upper pole.

Treatment.—Once the diagnosis is made, surgery holds the key to dramatic cure. Many types of operation have been performed, from simple ligature of the ureter (Alban Andrews and Vernon, 1944) to a complete removal of the supernumerary portion of kidney together with its ectopic ureter.

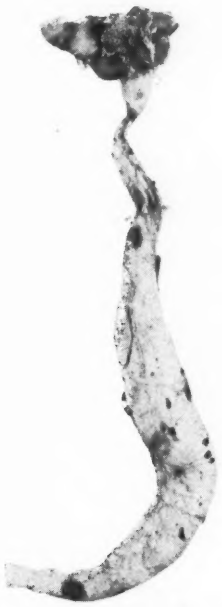

FIG. 654.—*Case* 1. The accessory kidney and ureter removed at operation. Note the wide dilatation. ($\times \frac{2}{3}$.)

There is no doubt that the latter is the most satisfactory and has been carried out in all the cases here recorded (*see Figs.* 654, 657, 661, 665).

The kidney is exposed through an incision in the loin, which can be extended into the abdomen as necessary. The small accessory portion of kidney with its own leash of vessels and ureter attached can usually be separated or divided off from the main structure. Preliminary ligation of the accessory vessels allows delineation, where there is difficulty in recognizing the line of separation. If kidney tissue has to be divided, the hæmorrhage is readily controlled by a few mattress sutures. With the upper portion isolated, the ectopic ureter can be freed from its fellow and untwisted from above down. It should be followed down as far as is possible, and this can be satisfactorily achieved by extending the loin incision or by making a separate abdominal incision with an extraperitoneal approach to the lower ureter.

In *Cases* 1, 2, and 4, the lower end was sufficiently attenuated to make ligation easy. In *Case* 3 the lower segment was very wide, so that after division a short blind sac remained which required subsequent excision.

Where the kidney is not divisible, or where the ureter is not double, a formal nephrectomy may be the only satisfactory course.

CASE REPORTS

Case 1.—**Ectopic ureter (L).** (*Figs.* 653, 654). Marlene C., aged 5, was first seen in October, 1949, and admitted in January, 1950.

HISTORY.—Constant day wetting from birth. Dry at night from the age of 18 months. Dry in bed by day unless sitting up. Passed urine normally otherwise.

ON EXAMINATION.—Apart from severe scalding of the buttocks and thighs, no abnormality detected on routine physical examination. On inspection of the vulva, an ectopic orifice could be seen below the external meatus. Efflux of urine could be watched. After injecting indigo-carmine intravenously, dye in sufficient concentration to stain a swab blue was seen to issue from this orifice. It was also recovered from the bladder in good concentration.

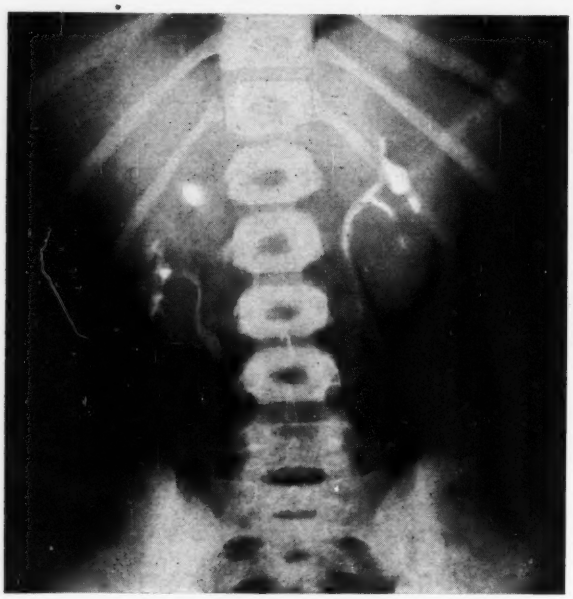

FIG. 655.—*Case* 2. Intravenous pyelogram, 10-min. film, showing abnormal shadow at the upper pole of the right kidney.

INVESTIGATIONS.—Urine : sterile. Blood-urea 28 mg. per cent. Intravenous pyelogram revealed a double pelvis and ureter on the left side (*Fig.* 653). The right kidney was normal. Cystoscopy revealed two normal ureteric orifices. In the retrograde films there was distortion of the shadow at the left upper pole. Attempts to catheterize the ectopic orifice failed. The opening proved to be too small to take a ureteric catheter and a fine probe passed only 1 cm.

PROVISIONAL DIAGNOSIS.—Ectopic ureter connected with the upper part of the left kidney.

OPERATION (T. T. H.).—Exposure of the left kidney through the loin revealed a double kidney, the upper and smaller portion of which was separated from the remainder by a thin line of fibrous tissue. A leash of vessels to this area was divided and the accessory kidney tissue dissected off the kidney proper. Issuing from this upper portion was a dilated tortuous ureter which was then freed from the normal one and followed down to the pelvic brim. At this point it narrowed to a striking degree. Through a paramedian incision with an extra-peritoneal approach the ureter was freed down to the broad ligament, crushed, divided, and the stump ligatured. The specimen removed is seen in *Fig.* 654.

POST-OPERATIVE CONVALESCENCE was uneventful and the child was dry from the time of operation although sitting up. Two months later she was still completely continent.

Case 2.—**Ectopic ureter (R).** (*Figs.* 655–657).

Barbara L., aged 10. First seen at this hospital in November, 1946.

HISTORY.—Constant day wetting from birth. Dry by night since the age of 3 years. Dry by day if in bed lying down, but becomes wet when she sits up. Passes urine normally otherwise.

ON ADMISSION.—The child was admitted to hospital in March, 1947, and investigated but no cause for the wetting was found. As she was dry most of the time in hospital (probably because she was lying in bed) it was felt that there was no organic cause for the symptoms.

Following her discharge she relapsed completely.

FIG. 656.—*Case* 2. Retrograde pyelogram showing a normal outline of the left kidney with a distorted pelvis and cut-off upper pole on the right side.

RE-ADMISSION.—She was re-admitted in February, 1950. There was no significant change in the symptoms, but attacks of right-sided abdominal pain with vomiting were occurring every few weeks.

ON EXAMINATION.—Except for excoriation of the skin in the vulval region, routine physical examination was negative. The child was very apprehensive as she had been seen by many doctors, including psychiatrists. She soon gained confidence when she appreciated that no painful procedures were proposed. On inspection of the vulva, urine could be seen trickling from the urethra. After packing the vagina with a petroleum jelly swab and gently everting the urethral edge with another, urine could be seen issuing from a small orifice on the right side. This opening could be made to efflux by supra-pubic pressure. Methylene blue was inserted into the bladder and a vulval pad placed in position. After an hour with the child ambulant, the pad was wet but not stained with the dye, which was afterwards recovered from the bladder in good concentration. This excluded the bladder as the source of the leakage.

INVESTIGATIONS.—The urine was sterile. Blood-urea 26 mg. per cent. Intravenous pyelograms revealed an abnormal shadow at the upper pole of the right kidney (*Fig.* 655). The left kidney appeared normal. Cystoscopy showed two normal ureteric orifices. Retrograde pyelograms revealed a distorted shadow of the right kidney (*Fig.* 656). Attempts to pass a ureteric catheter into the ectopic orifice failed owing to the restricted lumen.

PROVISIONAL DIAGNOSIS.—Right ectopic ureter.

AT OPERATION (T. T. H.).—The right kidney was exposed through the loin. There was a small accessory kidney, fused to the upper pole, and two ureters, the lower of which was normal in appearance and the upper

of which was dilated and tortuous. A leash of vessels to the upper pole was tied and this enabled delineation of the accessory tissue to be easily made by the ensuing congestion. No plane of cleavage could be found between the two portions and division with a knife was necessary. The upper pole was repaired by oversewing with mattress sutures of catgut. The dilated and tortuous upper ureter was followed down and freed from the normal one. A gridiron abdominal incision was made and with an extraperitoneal approach the lower end of the

FIG. 657.—*Case* 2. Accessory kidney and ureter (right), removed at operation. (× ⅜.)

ectopic ureter was seen to enter the broad ligament. It was crushed, divided, and the stump ligatured. (Specimen, *Fig.* 657).

POST-OPERATIVE PROGRESS.—Uneventful, the child being dry from the day of operation.

Case 3.—**Ectopic ureter (L).** (*Figs.* 658–661).

Judith T., aged 6½, was first seen as an out-patient in May, 1947

HISTORY.—Attacks of abdominal pain with fever and vomiting for four years. The child had been admitted to another hospital on four occasions and treated for 'pyelitis'. The urine was stated to be turbid during the attacks.

ON EXAMINATION.—The child seemed quite well and a catheter specimen of urine was sterile. The mother was instructed to bring the child back when next an attack occurred.

She was admitted in July, 1948, having had two further attacks of abdominal pain with frequency and dysuria, accompanied by pyrexia and vomiting. The attacks occurred at six-monthly intervals and lasted six weeks. During these attacks the child was said to pass intermittently clear and turbid specimens of urine.

She was frequently wet by day, but dry by night except during the attacks, when 'enuresis' developed.

EXAMINATION ON ADMISSION.—A flushed child with T. 102·8, P. 130, R. 35. The abdomen was tender in the left upper quadrant and tenderness was most marked in the renal angle. A specimen of urine showed many pus cells. A provisional diagnosis of 'recurrent pyelitis' was made and treatment with sulphacetamide commenced. There was subsequent improvement.

During her stay in hospital a catheter specimen was taken. This revealed clear urine, but immediately afterwards the child sat up and passed 5 c.c. of greenish pus.

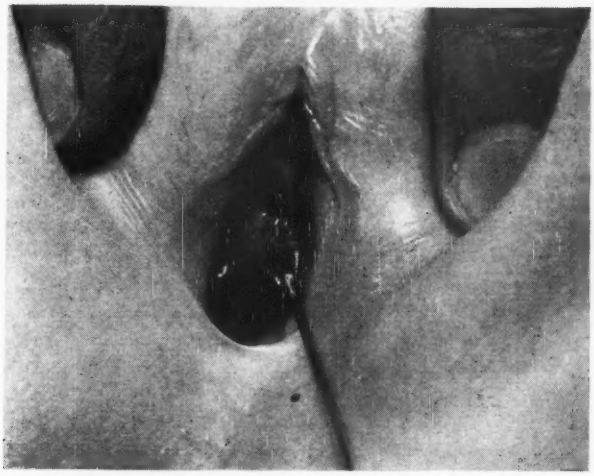

FIG. 658.—*Case* 3. An accessory orifice can be seen between the urethra and the vagina and is indicated by a probe.

At this point she was referred to the Urological Department.

Further Investigations.—On examining the external genitals, an ectopic orifice was seen in the vestibule, below and to the left of the urethral meatus (*Fig.* 658).

A catheter passed into the urethral orifice drew clear urine, while a second, passed into the ectopic opening,

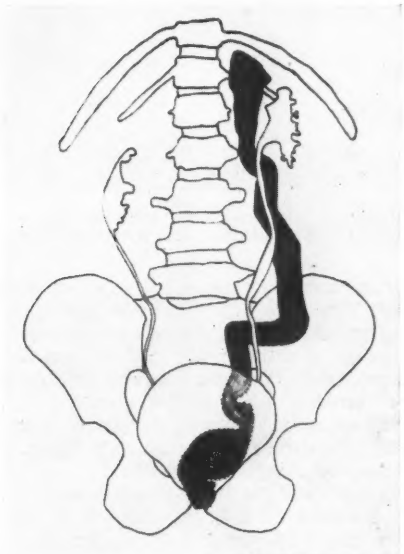

FIG. 659.—*Case* 3. Composite tracing (reduced) from pyelogram and ureterogram.

drew thick turbid purulent urine (sterile on culture). Blood-urea, 38 mg. per cent.

Intravenous pyelography revealed an apparently normal left kidney and an ectopic right kidney, situated opposite the 3rd and 4th lumbar vertebræ and rotated through 90° (*Fig.* 659).

The cystoscope was passed into the urethra and a normal bladder and two ureteric orifices were seen.

These were catheterized. The cystoscope was withdrawn and introduced into the posterior orifice. A large cavity was seen, which appeared to be lined by mucosa and at the top of which was a large gaping orifice.

Retrograde pyelography confirmed the apparently normal left kidney, and the ectopic rotated right. Injection of dye into the posterior orifice showed a tortuous dilated track running up to the region of the upper pole of the left kidney (*Fig.* 660).

A cystogram revealed a normal bladder outline and no reflux.

A composite tracing of the radiological findings is shown in *Fig.* 659.

DIAGNOSIS.—A diagnosis of a left-sided ectopic ureter was made.

AT OPERATION (T. T. H.).—The left kidney was exposed through an oblique incision. The accessory

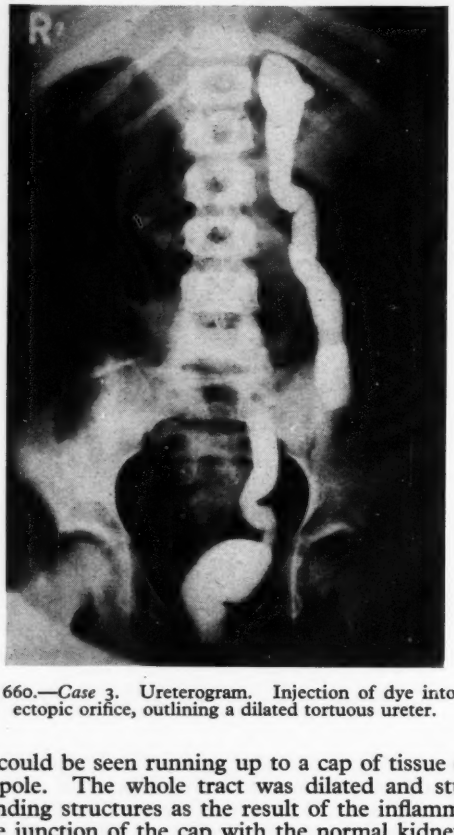

FIG. 660.—*Case* 3. Ureterogram. Injection of dye into the ectopic orifice, outlining a dilated tortuous ureter.

ureter could be seen running up to a cap of tissue on the upper pole. The whole tract was dilated and stuck to surrounding structures as the result of the inflammation.

The junction of the cap with the normal kidney substance was separated by dissection and the upper pole of the kidney repaired with mattress sutures. The tortuous ureter was freed down to the pelvic brim. It was crushed and divided and the stump ligatured. The specimen removed is seen in *Fig.* 661.

POST-OPERATIVE PROGRESS.—Cystoscopy and radiography of the dilated stump showed a considerable reduction in size within a month. The child was discharged with a proviso that should progress not be made the remaining stump would be excised at a later date. Some degree of enuresis persisted with intermittent pyuria. Excision of the stump was therefore carried out with successful results.

Case 4.—**Bilateral ectopic ureter.** (*Figs.* 662–666).

Mary P., aged 4½, was first admitted to hospital at the age of 10 months with diarrhœa and vomiting. The child was ill with a temperature of 103°. The urine was heavily infected with *B. coli*. In spite of treatment with sulphonamides, mandelic acid, and potassium citrate the infection persisted. The child seemed well, but continued to run a temperature. She was transferred to Great Ormond Street after eight months in hospital (March 9, 1947).

ON EXAMINATION.—A child underweight for her age (1½ years). Physical examination revealed a severe vulvitis but no other abnormality.

INVESTIGATIONS.—Hb, 80 per cent. Blood-urea, 36 mg. per cent. Urine heavily infected with *B. coli*. Cystoscopy showed a red injected bladder mucosa and a capacity of only 1¾ oz. There were two normal ureteric

FIG. 661.—*Case* 3. Pathological specimen. The accessory kidney with ureter (left) to level of pelvic brim. (Dilated terminal stump left and removed two years later.) (× ⅓.)

orifices. Only the left ureter was catheterized. Retrograde pyelography showed a normal pelvis *rather low in position.*

Following this the child developed a temperature which was controlled by sulphasuccidine. A week later the temperature had settled and she was discharged to the Out-patient Department. The urinary infection (*B. coli*) persisted.

For the next six months she continued to have attacks of fever and abdominal pain. She was wet day and night and had a sore irritable vulva. The organisms cultured from the urine were shown to be sensitive to sulphadiazine and sulphathiazole, and she was given a course of the former. An intravenous pyelogram was attempted but failed owing to difficulty in finding a vein. The abdominal pain subsided and, although still wet all the time, she was sent back to her own practitioner, who looked after her until her next admission (June 7, 1949).

ON RE-ADMISSION.—On this re-admission the *history* was that she was continually wet. There had been intermittent bouts of abdominal pain with fever and the mother stated that the child frequently passed slime from the urethra, often with pain severe enough to make her scream.

Examination revealed a well-nourished child. There were no abnormal findings on routine physical examination. Inspection of the perineum revealed slight excoriation,

FIG. 662.—*Case* 4. Retrograde pyelogram. Note low position and slight defect of upper calices.

and urine could be seen trickling constantly from the meatus.

Investigations.—R.B.C.'s, 3,210,000; W.B.C.'s, 6100. Blood-urea, 40 mg. per cent. Urine grew *B. coli* insensitive to all sulphonamides but sensitive to streptomycin.

Cystoscopy showed a normal bladder mucosa and two normal ureteric orifices. Ureteric catheters were passed and retrograde pyelograms showed two normal outlines (*Fig.* 662). (Subsequent review of these films shows that the left kidney was lower than the right and both kidneys were lower than normal, a point which was missed at the time.)

A course of streptomycin was given and the child discharged.

SECOND RE-ADMISSION.—She was sent up again by her doctor on April 28, 1950, because she was still wet night and day. According to the mother nothing made any difference to the wetting. Restriction of fluid, frequent potting, or posture had no effect. In spite of this she passed urine at regular intervals like a normal child.

Examination revealed a healthy, intelligent little girl who was most co-operative and patient while being examined. There were still no abnormal findings in the abdomen. Examination of the urethra showed frequent trickles of urine. By everting the urethra in a good light, a small opening could be seen on the posterior lip from which efflux of clear urine gushed. A little pressure suprapubically caused more frequent efflux.

A Diagnosis of ectopic ureter was made and the child re-admitted for further investigation.

Investigations.—Blood-urea, 36 mg. per cent. Urine sterile. Intravenous pyelograms revealed the abnormal shadows of a double kidney on each side (*Fig.* 663). The upper portions appeared to be dilated and explained the low position of the outlines seen in the retrograde films of the previous year. The dye tests were unsatisfactory on account of her frequency, but indigocarmine injected intravenously was seen to issue from the ectopic orifice and stained a vulval pad eighteen hours later, when the bladder urine was being passed clear. A careful search was made for any additional openings in

FIG. 663.—*Case* 4. Excretion pyelogram, 10-min. film, showing bilateral double kidney. Some dilatation upper half.

view of the intravenous pyelograms, but none could be seen.

A ureteric catheter was passed into the ectopic opening very easily without anæsthetic, and dye injected. This

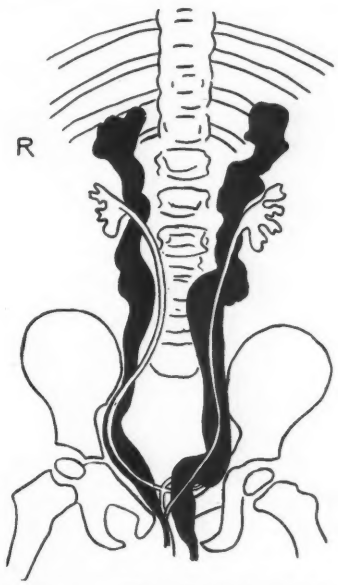

FIG. 664.—*Case* 4. Bilateral ectopic ureter. Composite tracing (reduced) of pyelograms and ureterograms (Right, pre-operation; Left, taken during operation).

showed a dilated tortuous track leading to the upper pole of the right kidney (*Fig.* 664).

A diagnosis of a right ectopic ureter was made. It was thought highly probable that a similar condition existed on the left side although the opening could not be

seen. It was decided to remove the right ectopic ureter and to await the result on the wetting. Should the child still be wet with incontinence of the ' ectopic ureter type ', the left side would be proceeded with.

Under the anæsthetic a further search was made of the urethral meatus—but no further openings could be seen.

AT OPERATION.—The right kidney was exposed through an oblique incision. There were two ureters, the one to the lower half of the kidney being of normal calibre. The upper portion of the kidney was soft to

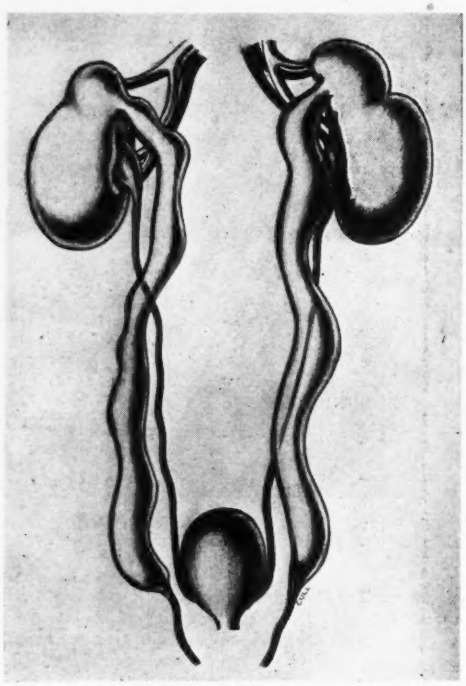

FIG. 665.—*Case* 4. Bilateral ectopic ureter. Diagrammatic drawing.

feel and connected with a large tortuous and dilated ureter which ran down alongside the normal one. Demarcation of the upper renal segment was not clear, but ligation of supplying vessels immediately defined it. The upper portion was resected and the upper pole of the lower kidney repaired by a series of mattress sutures. The large dilated ureter could now be freed from the normal one and followed down into the pelvis. By extending the incision, it was isolated to a point just above the vaginal vault, where it was crushed, divided, and ligatured. The wound was then closed.

The day after operation the child was still wet, although not as wet as she had been before. This was not the wetting of post-operative incontinence, which is common in small children, but was fairly constant and small in amount. Recovery was straightforward, but the incontinence continued.

THIRD RE-ADMISSION.—After two months' convalescence she was re-admitted and the left kidney exposed. An exact replica of the anomaly as found on the right side was revealed. The distended ureter was filled with dye and a ureterogram taken (*Fig.* 665).

The upper renal segment and ureter were then removed as on the right side through a single incision.

The child's recovery caused no anxiety and she was completely continent immediately following the second operation, and has remained well and symptom-free.

SUMMARY

The incidence and embryology of ectopic ureter are briefly described.

Four cases in girls are recorded, unilateral in 3, bilateral in 1—all cured by operation.

The symptoms are discussed, with particular reference to the type of incontinence as seen in young children.

The methods of investigation with a view to diagnosis are outlined. Emphasis is laid on the value of pyelography, when a confirmatory ureterogram

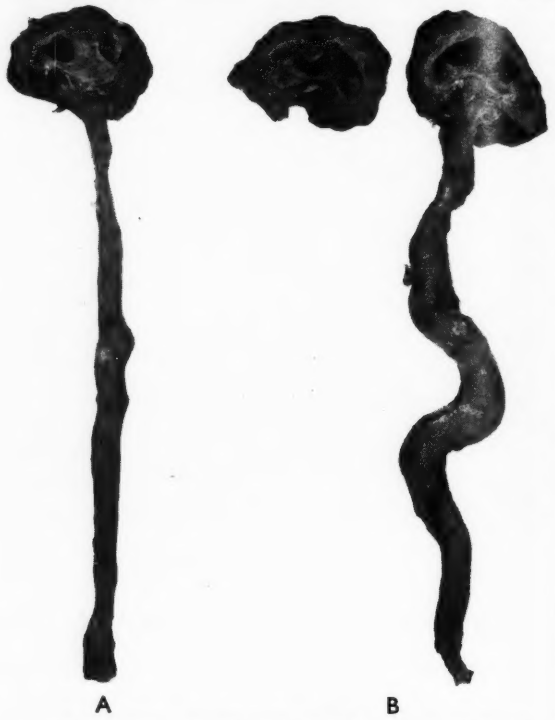

FIG. 666.—*Case* 4. Operation specimens. A, Right side, removed May 8, 1950. (× $\frac{1}{2}$.) B, Left side, removed July 13, 1950. (× $\frac{6}{11}$.)

by direct catheterization of the ectopic ureter cannot be obtained.

The operation of heminephro-ureterectomy, as carried out in these cases, is described.

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SMALL-GUT OBSTRUCTIONS FOLLOWING COMBINED EXCISION OF THE RECTUM

WITH SPECIAL REFERENCE TO STRANGULATION ROUND THE COLOSTOMY

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Symptoms of intestinal obstruction are not infrequent after combined excision of the rectum. Most often these are due to some degree of paralytic ileus, but in a proportion of cases a true mechanical obstruction is present. In this paper we have analysed the frequency and precise causes of post-operative mechanical obstruction in a consecutive series of 1302 cases treated by combined excision at St. Mark's Hospital from January, 1936, to December, 1949, and have discussed their diagnosis, treatment, and possible prevention.

Incidence.—In this series 37 patients developed a definite obstructive lesion as proved by laparotomy or autopsy, making an incidence of post-operative obstruction of 2·84, or approximately 3 per cent. Four other cases presented strong clinical evidence of a mechanical obstruction, but these responded successfully to conservative treatment with suction through a Miller-Abbott tube and intravenous fluids, and consequently they have not been included.

Types of Obstruction.—These can be classified most conveniently as follows :—

1. *Obstructions not specifically related to the Nature of the Operation* (15 *cases*).—In 13 cases the obstruction was due to adhesions which had formed between adjacent loops of small gut or between small gut and the parietes, particularly the anterior parietal wound, and which might have followed any abdominal operation. They need not be further discussed.

In one case the obstruction was produced by a Meckel's diverticulum which had ensnared the lower ileum close to the ileocæcal junction. Another case had a strangulated hernia through the main paramedian wound.

2. *Obstructions arising in connexion with the Pelvic Peritoneal Floor* (12 *cases*).—In 10 of these a loop of small gut had become adherent to the suture line in the pelvic peritoneum and was thereby kinked. The adhesions were usually to the upper end of the suture line ; in one instance, indeed, the bowel was stuck to the tails of the knot at the upper extremity of the continuous catgut suture used to close the pelvic peritoneum.

In a further case a gap had developed in the middle of the suture line in the pelvic floor and through this a knuckle of small bowel had become strangulated.

In yet another case the obstruction was produced by the mechanism described many years ago by Miles (1926). During the mobilization of the pelvic peritoneal flaps preparatory to suture the developmental adhesion which frequently exists between the peritoneum and the lower ileum 5 or 6 in. from the ileocæcal junction may be pulled down and cause angulation of the bowel as shown in *Fig.* 667. This can be readily corrected by division of the adhesion concerned, but in one case in this series this step, which was needed, was unfortunately omitted, and an obstruction developed necessitating laparotomy.

3. *Obstructions originating in the Vicinity of the Colostomy* (10 *cases*).—In 5 cases the small gut had become obstructed by adhesions to the peritoneal aspect of the colostomy wound or to the edge of

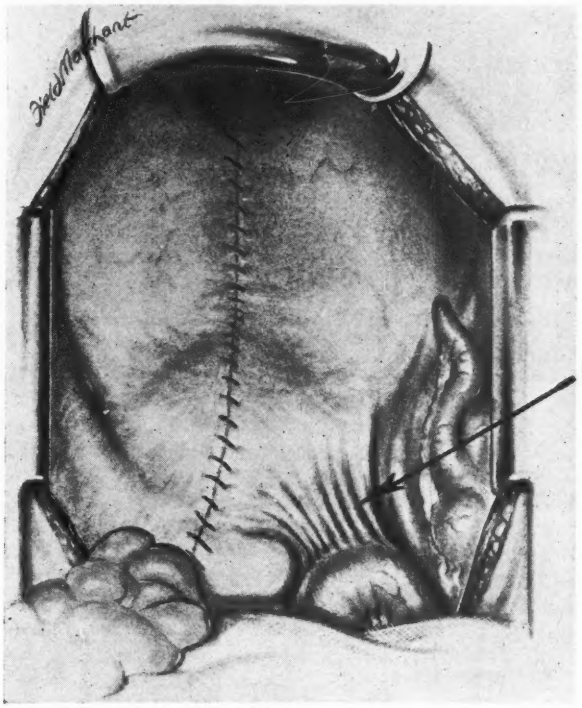

Fig. 667.—Severe degree of kinking of lower ileum produced by traction on ileal band during suture of pelvic peritoneal floor after combined excision of rectum.

mesocolon stretching forwards to the colostomy. Three of these obstructions arose in the series of 1132 cases with left iliac colostomies, 2 in the very much smaller series of 170 patients provided with central colostomies.

In one case obstruction had been caused by strangulation of a loop of ileum in a hernia through the colostomy wound. Such herniæ are common, but usually have broad necks and are easily reducible ; and strangulation has never hitherto been recorded in our follow-up of rectal cancer cases at St. Mark's Hospital, though this has included over 3000 patients with colostomies.

In one other case an unusual type of herniation with strangulation was present between the peritoneal leaves of the iliac mesocolon.

In the remaining 3 cases the herniation was through the narrow peritoneal isthmus on the outer

side of the colostomy, the affected loop of small bowel passing through this gap and becoming strangulated. *Figs.* 668, 669 illustrate the lesions

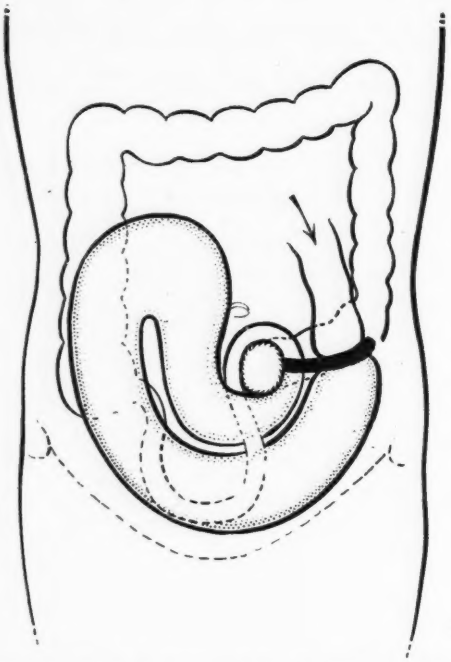

FIG. 668.—Diagram of strangulation obstruction of small gut present on outer side of colostomy in one case after combined excision of rectum.

encountered in these cases. It may be mentioned that in one of the other cases in which obstruction was caused by an adhesion between the lower ileum

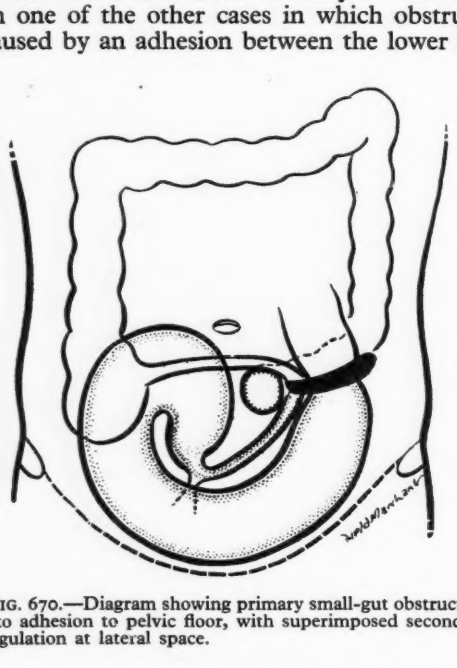

FIG. 670.—Diagram showing primary small-gut obstruction due to adhesion to pelvic floor, with superimposed secondary strangulation at lateral space.

and the pelvic floor, the affected loop had passed through the lateral space, and as a result of the intestinal distension caused by the obstruction, a secondary constriction and strangulation had developed at the lateral space, as shown in *Fig.* 670.

The danger of herniation through this lateral space has been fully appreciated at St. Mark's Hospital ever since Gabriel's classical paper on the subject in 1928, and until recently we have always adopted his suggestion to make the space small by bringing the colostomy out through a left iliac incision rather than the main paramedian wound, and to close

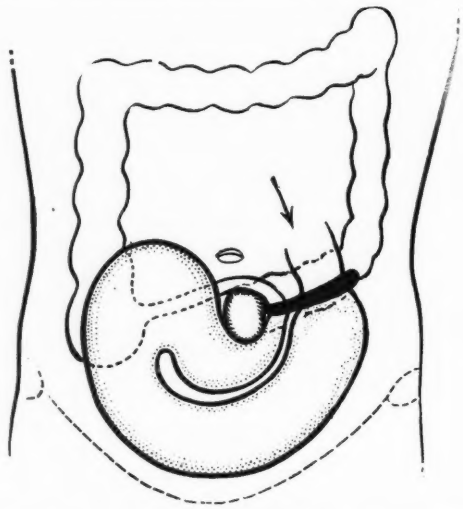

FIG. 669.—Diagram of operative findings in two other cases of lateral space obstruction.

it at the time of the operation by means of a purse-string suture (*Fig.* 671). In the last 2½ years, however, some of us have followed the lead of certain American surgeons such as the late Dr. Tom Jones, of the

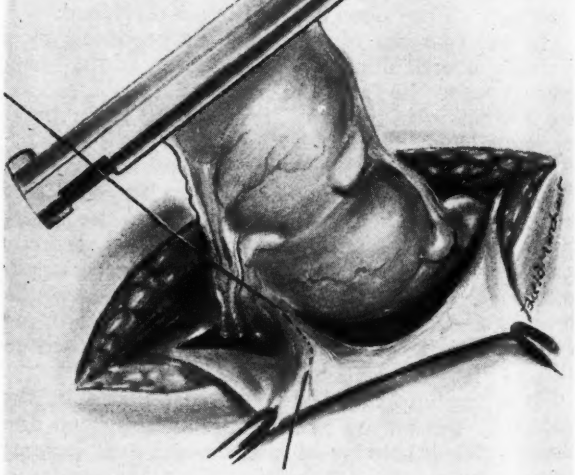

FIG. 671.—Closure of lateral space by purse-string suture inserted as recommended by Rankin (1927) and Gabriel.

Cleveland Clinic, and Dixon and Mayo, of the Mayo Clinic, and have returned to the practice of making a central colostomy, the colon being brought out through the paramedian wound. The main virtue of this type of colostomy is that it is more convenient for subsequent management in obese subjects than one in the left iliac region. With the central colostomy,

however, the lateral space is very much larger than with an iliac colostomy, as indicated in *Fig.* 672, and we have generally made no attempt to close it in these cases, partly because of the technical difficulties of so doing and partly because we imagined that it was so capacious as to present no danger from obstruction. Our experience has shown that this is not so, because in the 170 cases that were given central colostomies 3 lateral-space obstructions occurred. By contrast, not one of the 1132 cases having left iliac colostomy with closure of the lateral space developed this complication.

Time of Occurrence.—In this respect the cases fall into two main groups: those in which obstruction developed soon after operation, whilst the patient was still in the ward, and those in which it arose months or years after discharge from hospital. *Table I* records the time of diagnosis of the obstruction in the 37 cases, and it will be seen that 25 were in the early and 12 in the late group. It would appear, therefore, that the greatest risk of obstruction

Table I.—Time of Detection of 37 Small-Gut Obstructions after Combined Excision of Rectum in 1302 Cases at St. Mark's Hospital

Period since Operation		No. of Cases in each Period	
1st week	Hospital period.	5	25
2nd "		10	
3rd "		4	
4th "		6	
2nd month	After discharge from hospital.	2	12
2nd year		1	
3rd "		1	
4th "		1	
5th "		2	
6th "		2	
7th "		1	
8th "		1	
14th "		1	
		37	

lies in the immediate post-operative period, and when this has been successfully surmounted the chances of a later obstruction developing are relatively slight. It must be borne in mind, however, that the series from which these cases are derived includes patients operated on as late as December, 1949, and that the second group of obstructions is necessarily incomplete. Further obstructive complications must therefore be anticipated, especially in the cases treated more recently. All three main types of obstruction were found in both the early and late groups.

Diagnosis.—The diagnosis of late obstructions arising after the patient's discharge from hospital has usually been straightforward. The sudden onset and persistence of abdominal pain and vomiting and the cessation of colostomy actions have at this stage admitted of no other explanation than that of a mechanical obstruction, and the patients have usually been transferred to hospital without delay for further operative treatment. However, in 3 cases taken into local hospitals, though an obstruction was diagnosed clinically, it was thought probably to be due to malignant deposits in the peritoneum with adherence and kinking of one or more loops of small gut, and no operation was advised. At post-mortem examination it was unfortunately found that the obstructing lesion in all of them was a simple fibrous adhesion which could easily have been divided at laparotomy.

The diagnosis and management of the early obstructions has been much more difficult because of the confusion that often exists with paralytic ileus during the immediate post-operative period. Classically, of course, cases with mechanical obstruction differ from those with paralytic ileus in that

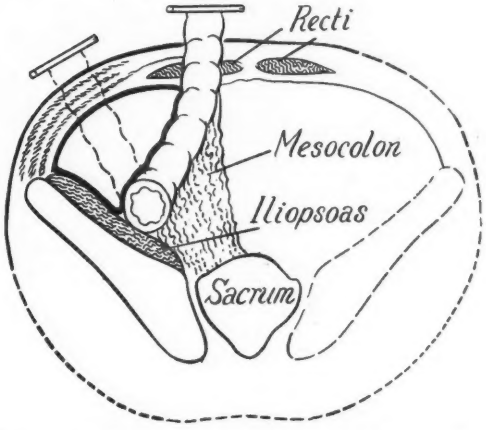

Fig. 672.—Diagram showing difference in size of lateral space with left iliac and left rectus colostomy.

they have intestinal colic and the symptoms frequently originate not immediately after operation but some days later. In our experience, however, such a clear distinction could not always be drawn. Many of our patients with mechanical obstructions did not have colicky pains and on auscultation of their abdomens no exaggerated peristalsis could be elicited, but only occasional faint sounds heard, such as are often present in cases of paralytic ileus. Further, it often happened that the symptoms commenced soon after operation without any latent interval, presumably because the mechanical obstruction supervened on a pre-existing paralytic ileus. One very striking feature of the obstruction cases, however, was that though the patient may have had abdominal distension, vomiting, and non-passage of fæces and flatus from the time of the operation, these symptoms usually abated with gastric suction and intravenous fluids, and for a short period the colostomy may have acted again and the distension have lessened though seldom have completely gone. Then further obstructive symptoms appeared, which again may have subsided with conservative measures, only to return again later. This intermittency of symptoms was very suggestive of a mechanical obstruction and where it was noted, especially when the symptoms recurred twice, it was generally felt safer to explore the abdomen. Usually this policy yielded good dividends, but inevitably there were errors, and some cases thought clinically to have mechanical obstruction were found at laparotomy only to have paralytic ileus. On the other hand, one case which died on the tenth day apparently of ileus and cardiac failure was shown at autopsy to have a kinking of the lower ileum by an adhesion. Radiological examination of the abdomen was not

practised as a routine; in so far as it was used it was not found to be of any assistance in distinguishing between paralytic ileus and mechanical obstructions.

As for the differential diagnosis between the various forms of obstruction, this was generally impossible on clinical grounds except in the two cases with strangulated ventral herniæ, one in the main paramedian wound, and one in the colostomy wound. In all the other cases the most that could be done clinically was to recognize the existence of some mechanical obstruction and the necessity for exploration of the abdomen.

Treatment.—It will be seen therefore that the treatment of these cases was usually along conservative lines in the first instance, with gastric suction and intravenous fluids, till a definite decision was reached as to the presence of a mechanical obstruction. Once this diagnosis was made, laparotomy was advised. The abdomen was opened by a right paramedian exploratory incision and the various lesions encountered were dealt with appropriately, adhesions being divided, herniæ reduced, and kinkings corrected. In no case was strangulation severe enough to cause gangrene and require resection.

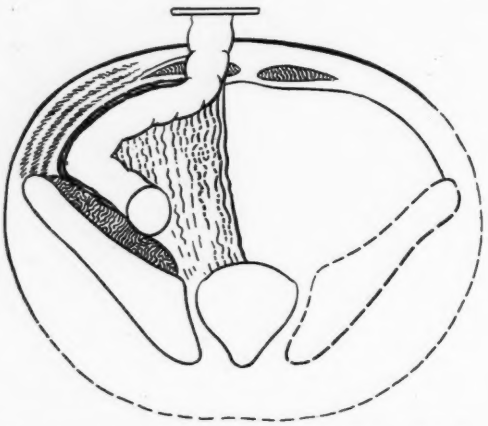

FIG. 673.—Diagram showing state of affairs after closure of lateral space with left rectus colostomy by suturing iliac colon to anterior parietal peritoneum. Note pronounced mesocolic shelf.

In the cases with lateral space herniæ it appeared at first that in order to secure reduction of the strangulated ileal coils it might be necessary to break the constricting ring by dividing the iliac colon between clamps flush with the anterior parietal peritoneum. But despite considerable intestinal distension reduction of the gut was eventually achieved without resorting to this manœuvre. The space that then remained was very large, much larger than that present normally with a median colostomy, because during the period of obstruction the colon in the inner wall of the space had been stretched on the right, and the possibility was considered of having to transfer the colostomy from the midline to the left iliac region in order to narrow the space and facilitate its closure. However, its obliteration was finally achieved without this step, by suturing the iliac colon to the anterior parietal peritoneum from the left paracolic gutter to the colostomy near the midline (*Fig.* 673). This certainly disposed satisfactorily of the open lateral space, but it left a rather pronounced mesocolic shelf which gave rise to a further obstruction in one of the cases, necessitating a third laparotomy at which the findings depicted in *Fig.* 674 were revealed. Reduction of this fresh hernia and division of the adhesion responsible was followed by an uninterrupted recovery.

Mortality and Results.—The three late obstruction cases that were treated expectantly on the erroneous diagnosis of peritoneal recurrences all died. One other early case diagnosed as a paralytic ileus and treated along conservative lines also died. The remaining 33 cases were all treated by operation; three of these died, one of myocardial degeneration soon after operation, another of bronchopneumonia, and a third of sudden collapse on the operating table. There were therefore altogether 7 deaths in 37 cases, making an overall mortality from mechanical obstruction of 18·9 per cent.

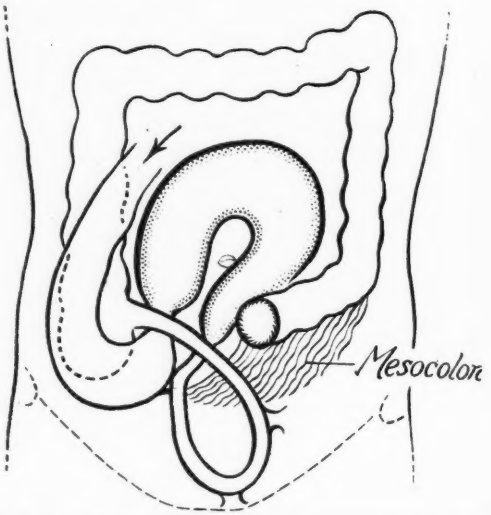

FIG. 674.—Diagram of findings at laparotomy for second obstruction in case with left paramedian colostomy. This arose after previous operation, at which lateral space strangulation was reduced and lateral space closed by method shown in *Fig.* 673.

Prevention.—The important question arises as to whether any of these post-operative obstructions could have been obviated by alterations in the technique of operation. As regards the non-specific adhesions, these are to be regarded as a problem of general abdominal surgery, and they will not be further discussed; only those obstructions peculiar to combined excision of the rectum will here be considered.

It is possible that the risk of formation of adhesions of the small gut to the pelvic floor might be minimized by careful operative technique. If the pelvic peritoneum is coapted with an ordinary running stitch, the raw edges of peritoneum are liable to project upwards into the peritoneal cavity, possibly increasing the risk of small bowel becoming adherent. It would seem preferable to use the suture shown in *Fig.* 675, which brings serous surfaces into apposition and turns the free edges downwards towards the pelvic cavity, where they can do no harm. Sounder union may also possibly be obtained by this method and the chances of a dehiscence leading to herniation lessened. In view of the fact that one obstruction

was due to a loop of ileum becoming stuck to the rather long tails of catgut left on the knot at the upper end of the suture line in the pelvic peritoneum, it is desirable that such tails should be cut short and buried. Finally the lower ileum should be inspected and any kinking due to traction on an ileal band by the mobilization and suture of the pelvic peritoneum

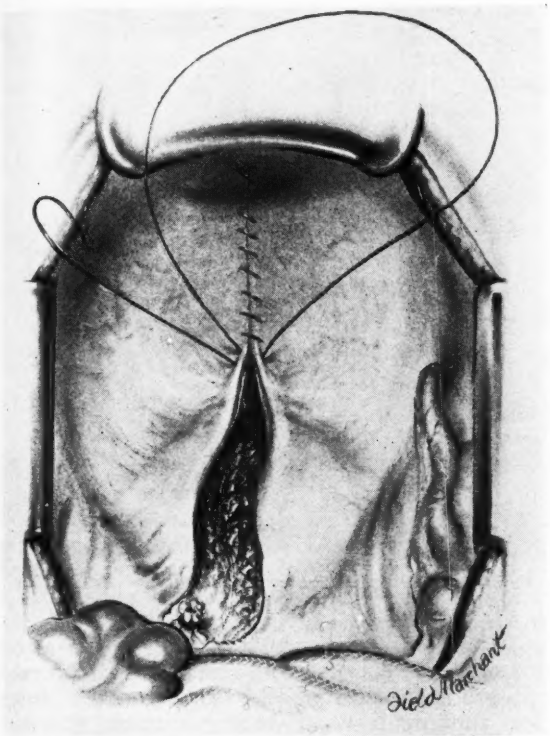

FIG. 675.—Suture of pelvic peritoneum to secure apposition of upper serous surfaces and avoid projection of free edges into peritoneal cavity.

should be rectified by scissor or scalpel dissection as required.

Obstructions in the vicinity of the colostomy can probably never be entirely eliminated, because there is always some risk of small bowel becoming adherent to the raw edge of iliac mesocolon or to the colon as it stretches forwards to the colostomy. Our statistics, however, show that the hazard is less with an iliac than with a central colostomy. The occurrence of a hernia between the leaves of the iliac mesocolon adjacent to the colostomy might suggest that these should be sutured to peritonealize this raw edge and prevent herniation, especially in fat subjects. We are of the opinion, however, that a suture of this kind would have to be inserted with great caution to avoid pricking the vessels in the mesocolon on which the blood-supply to the colostomy depends. It would probably do more harm than good in the long run and we would not advocate its routine use, though we admit that it might occasionally be advisable in dealing with a very fat bulky mesocolon.

As for herniation through the lateral space, it is perfectly clear that this is a real risk in these cases, whether the colostomy be established in the left iliac region or placed close to the midline. As it is a simple matter to obliterate the space at the time of the operation, there can be, in our view, no justification whatsoever for leaving it unclosed. Our experience with cases of lateral space obstruction has shown that closure of the space, even with a left paramedian colostomy, can be accomplished without too much difficulty if one uses the technique of a running stitch between the iliac colon and the anterior

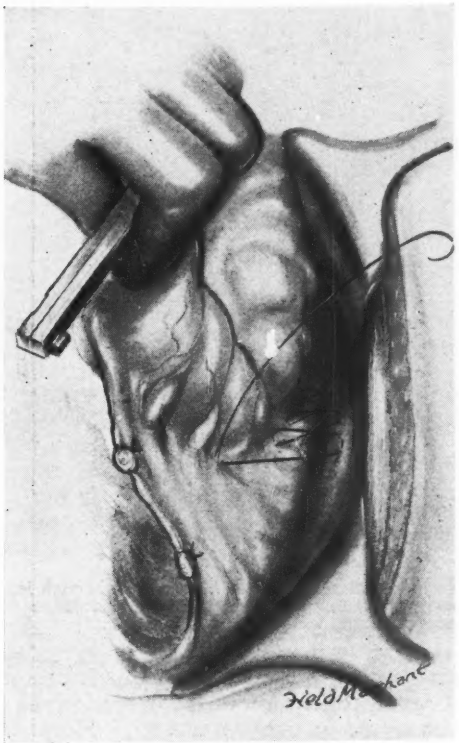

FIG. 676.—Technique for closure of lateral space with paramedian colostomy by stitching iliac colon to parietal peritoneum with running suture.

parietal peritoneum, as in *Fig.* 674. In several combined excisions recently, where we were particularly anxious to leave the patient with a midline colostomy, we have employed this method with satisfaction (*Fig.* 676). It has, however, the disadvantage of creating a prominent mesocolic shelf which might in itself give rise to trouble later from obstruction; some indication of this is afforded by the second obstructive episode already referred to in *Fig.* 674. It also requires a longer stump of iliac colon, a circumstance that must not be forgotten in planning this type of colostomy. For these reasons we feel that the midline colostomy should, as far as possible, be reserved for exceptional cases and that the routine should be the left iliac colostomy.

The closure of the lateral space with a left iliac colostomy is usually effected by the method introduced by Rankin and popularized in this country by Gabriel. It involves making a fair-sized gridiron or muscle-cutting incision in the left iliac region. The iliac colon is withdrawn through this and pulled downwards and medially, whilst the outer edge of the parietal peritoneum is retracted strongly laterally. This opens up the lateral space and usually creates a fold of peritoneum running across it, as in *Fig.* 671. A purse-string stitch is inserted along the fold from

the left edge of the wound almost to the bowel. When tied it effectively closes the space.

Our criticism of this procedure is that it requires an iliac wound a good deal larger than is really needed for the passage of the colon through the abdominal wall, particularly in fat patients. Consequently at the conclusion of the operation the wound has to be closed in part by sutures. However careful the suturing may be, such a wound, weakened by the presence of the colostomy, is more liable to give way subsequently and result in an incisional hernia. Incisional herniæ are admittedly almost the rule around colostomies however fashioned, but we are convinced that really severe herniæ can be avoided by the use of a small stab incision just large enough to transmit and lodge comfortably the emerging colon. We have certainly had a number of cases with colostomies made on this principle where there has been no herniation whatsoever. Consequently we are averse to the Rankin-Gabriel method of closing the lateral space and prefer to approach the space from within the abdomen through the main paramedian wound.

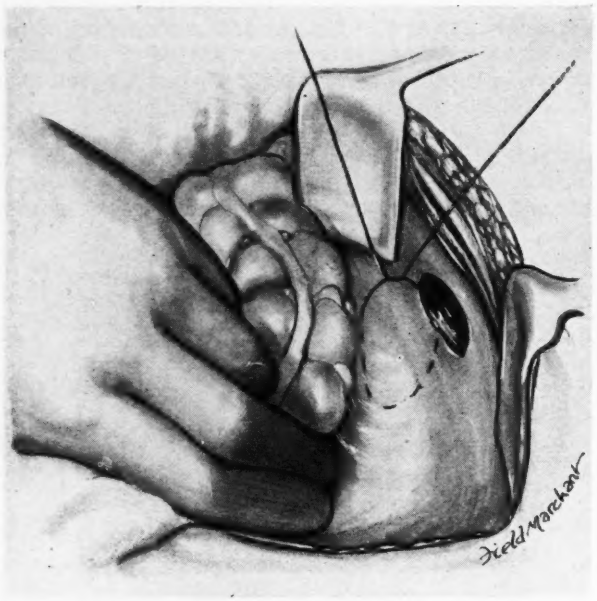

FIG. 677.—Method of closing lateral space with left iliac colostomy by purse-string suture inserted from inside abdomen: placing stitch.

Figs. 677, 678 illustrate the closure of the lateral space in this way. The surgeon stands on the right side of the patient and the assistant retracts the left edge of the paramedian wound to expose the inside opening of the left iliac stab wound. The colon stump is then drawn towards the surgeon, allowing easy access to the lateral space. A purse-string suture, preferably of fine linen or silk, is now inserted from the lateral peritoneal edge of the stab wound to the peritoneum just adjacent to the colon and back again. We find it a good plan to take as the very first bite of this stitch the muscle in the outer edge of the colostomy wound before catching up the peritoneum. The advantage of so doing is that when the stitch is tied the closed lateral space and the colon are drawn up against the parietes and no gap can occur in front of the purse-string suture due to falling back of the parietal peritoneum. The secret of easy closure of the lateral space from within is *to insert the stitch before drawing the colon through the abdominal wall.* Once the bowel has been brought through the iliac wound the surgeon's view of the lateral space is obscured and he has to approach it either from above or below the piece of colon running forwards to the anterior abdominal wall.

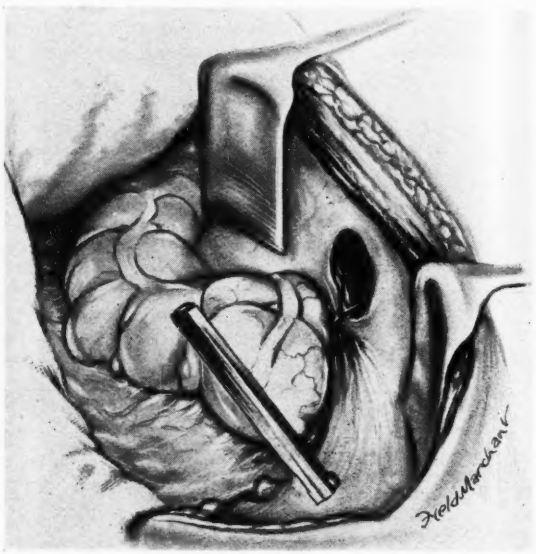

FIG. 678.—Closing lateral space from inside abdomen: purse-string suture tied.

SUMMARY

1. Post-operative simple mechanical obstruction of the small gut developed in 37, or approximately 3 per cent, of 1302 cases treated by combined excision of the rectum at St. Mark's Hospital. Of these, 25 originated within one month of the operation; the remainder some months or years afterwards.

2. The obstructive lesions encountered were of three types:—

a. Adhesions and other lesions *not specifically related to the nature of the operation.*

b. Adhesions, herniation or kinking *at the pelvic peritoneal floor.*

c. Adhesions or herniation *in the vicinity of the colostomy.* An important variety of these was strangulation through the lateral space.

3. The recognition of late obstructions was easy, but the diagnosis of obstructions arising in the immediate post-operative period was often difficult because of confusion with paralytic ileus. An important distinguishing feature was the intermittency of symptoms in obstruction cases. Differentiation between the various types of obstruction was usually impossible on clinical grounds.

4. The initial treatment was usually by gastric suction and administration of intravenous fluids till a definite decision was reached regarding the existence

of a mechanical obstruction and thereafter by operation at which adhesions were divided, herniæ reduced, and other lesions appropriately dealt with. No case required resection of gut.

5. Four cases of post-operative obstruction treated conservatively on mistaken diagnoses all died. Of the remaining 33 cases, all treated by operation, 3 died and 30 recovered.

6. The risk of pelvic floor obstruction can perhaps be minimized by suturing the pelvic peritoneum so as to bring the upper serous surfaces into apposition and turn the free edges downwards, and by avoiding long catgut tails to the knots.

7. In the prevention of obstructions in the vicinity of the colostomy the important points are to make the colostomy in the left iliac region rather than the midline, and to close the lateral space. It is considered that the left lateral space can best be closed from inside the abdomen by a method which is described.

We are much indebted to our colleagues at St. Mark's Hospital for kind permission to utilize their cases for the purpose of this inquiry.

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MALIGNANT DISEASE OF THE TESTIS*

WITH SPECIAL REFERENCE TO RADIOTHERAPY

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THE object of this communication is to discuss some of the facts associated with malignant disease of the testis, with special reference to the place of radiotherapy in its treatment.

Basing my remarks entirely upon a series of 147 cases seen at Westminster Hospital between 1930 and 1950, an attempt will be made to show that the histological type of the tumour, the stage of the disease, and the treatment employed have an important bearing on the prognosis.

Primary malignant disease of the testis is a relatively rare condition. According to the Registrar-General the deaths due to this cause in the year 1945 were only 281. Compare this with the commonest site for cancer—the stomach—which accounted for 7631 deaths in males during the same period. Dean (1935) estimated that malignant disease of the testis in fact accounted for some 2 per cent of all malignant tumours in males. Nevertheless, this condition, and more especially its treatment, is a subject which merits special consideration from the point of view of the radiotherapist, for irradiation unquestionably plays the major part in its control.

Although the histogenesis of the testicular neoplasms is not yet universally agreed, the work of various investigators such as Chevassu and Nicholson at the beginning of the century, Dew and Bell twenty-five years ago, and more recently Ewing (1940) and Willis (1948) have clarified the complex histopathology of these tumours. The old confused nomenclature has been abandoned and three well-defined groups are now recognized :—

1. *Seminoma.*—Variously known as the germinal-cell tumours, the spermatocytoma ; the embryonal carcinoma, or the dysgerminoma. This is the commonest tumour of the testis, and there were 84 such tumours in the present series.

2. *Teratoma.*—Variously known as the teratoid or mixed tumour, embryoma, or teratoid carcinoma. There were 61 cases in this series.

3. *The Chorionepithelioma* (Chorion Carcinoma). —This is the rarest of the malignant tumours of the testis, and fortunately so, for it carries the worst prognosis. Only 2 cases occurred in this series, and in spite of irradiation neither survived orchidectomy by six months.

This classification is justified on clinical grounds, by the age incidence, and by the prognosis.

No examples of the interstitial-cell tumour and tumours arising in the rete testis were seen in this series, and will therefore not be mentioned again in this communication.

The Origin of Testicular Neoplasms.—In considering the pathogenesis of testicular neoplasms it is necessary to mention briefly the early development of the testis. It is generally held that the seminiferous cells are derived from the columnar germinal epithelium which covers the mesoderm of the genital ridge medial to the Wolffian body. It is believed that this specialized epithelium grows down into the subadjacent mesenchyma, that the surface connexions are lost, and that the buried germinal epithelial cells constitute the primitive sex cells.

On the other hand Beard (1903), Felix (1905), and Keibel (Keibel and Mall, 1910), have shown that the germinal or sex cells are formed at a much earlier stage in the development of the embryo. They are derived from the morula or blastula and migrate through the entoderm into the mesoderm of the genital area when the cœlom is formed. These cells are not derived from any of the germinal layers and are totipotential and therefore capable of giving rise to tissues of all three layers.

Whether the seminiferous epithelium, then, is derived from the mesothelium of the genital ridge or migrates there from the morula, remains uncertain, but as teratoid tumours contain tissue from

* Based on a paper read at The Sixth International Congress of Radiology in London, July, 1950.

all three germinal layers and often grow from the region of the rete testes, where developmental errors might be expected, it is thought that they arise from the primitive undifferentiated cells of the genital ridge which failed to develop and become connected with the secretory tubules of the testis. Although dormant at first, they retain their capacity for growth and later become active.

The exciting cause of the neoplastic change is not known, but it has been suggested by Needham

FIG. 679.—Macroscopical specimen of a teratoma of the testis, showing the mixed nature of the tumour.

(1936) and others that teratomas are tumours arising from pluripotential embryonic cells which, during early development, have escaped the influence of the morphogenic hormones known as organizers, chemical substances of the nature of sterols, which control orderly development.

In 1906 Chevassu described the seminoma, and advanced the view that it was a carcinoma of the epithelium of the seminal tubules, but Ewing in 1911, demonstrating seminomatous tissue in a teratoma and finding 'minute traces' of cartilage and entodermal and ectodermal tissue in a seminoma, maintained that the latter did not arise from the seminal epithelium but was always a one-sided development of teratoma, a view still widely held.

However, Nicholson (1907) pointed out that in examining the seminal tubules near the edge of a seminoma it was difficult to differentiate between the cells of the normal epithelium and those of the new growth. This work and that of Dew (1925) and Deitermann (1937), strongly support Chevassu's theory, while Bell (1925), Hartmann and others (1922), and Willis (1948) have shown that all transitions can be traced between the normal seminal

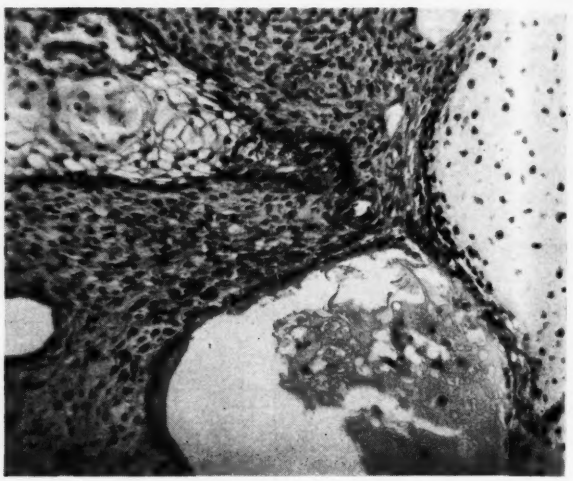

FIG. 680.—Photomicrograph of a teratoma of the testis, showing various epithelia, cartilage, and connective-tissue elements. (× 64.)

epithelium and the tumour tissue, and it is now generally conceded that Chevassu's theory was the correct one and that the seminoma is in fact a carcinoma of the epithelium of the adult seminal tubules.

Other authorities, however, such as Harvey, Dawson, and Innes (1940), hold that the two views

FIG. 681.—Macroscopical specimen of a seminoma showing the homogeneous consistency. (Approximately half size).

can be reconciled, and in support of this maintain that both seminomas and teratomas are derived from totipotent germinal cells in the germinal epithelium.

With regard to the chorionepithelioma, the generally accepted view is that its origin is the same as that of the teratoma, and the work of Ross (1932), McDonald (1938), and Handfield-Jones (1926) has shown that this tumour can frequently be found to contain other teratomatous elements.

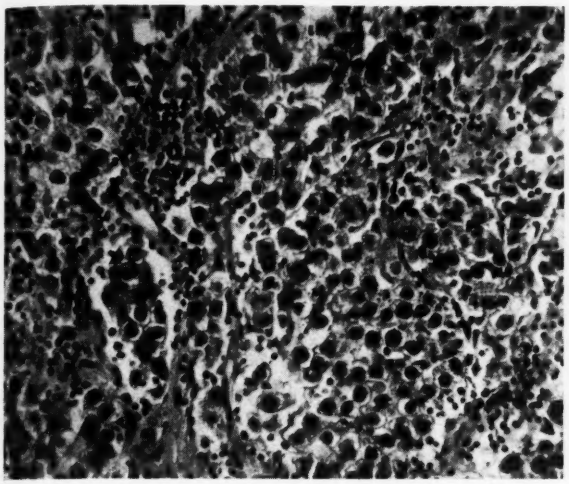

FIG. 682.—Photomicrograph of a seminoma. (× 64.)

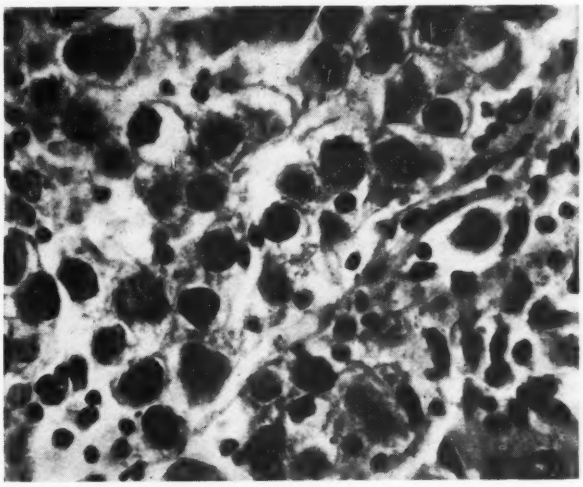

FIG. 683.—High-power view of the same tumour as in *Fig.* 682. (× 208.)

Morbid Anatomy and Histology.—The cardinal features of a *teratoma* are its great complexity and the fact that structures derived from all three germinal layers can be found in it. The tumour may be smooth or lobulated, soft or stony hard, or elastic in one place and firm in another. The tunica albuginea resists invasion and rupture, so that the testis may retain its shape for a considerable time, later becoming pyriform or round. On section the whole testis may be replaced by the tumour, or it may be stretched out like a wafer over one segment of the growth, which may be solid or riddled with cystic spaces of various sizes containing gelatinous material or fluid, the latter sometimes blood-stained. Interspaced between the cysts are solid areas containing fibrous tissue or sometimes cartilaginous nodules and patches of necroses and hæmorrhages (*Fig.* 679).

Microscopically the tissues may be of great variety (*Fig.* 680), mature or embryonic. Occasionally there may be remarkable differentiation—for example, intestinal epithelium sometimes with mucous-secreting cells, in close association with non-striped muscle; or ciliated epithelium of bronchial type in juxtaposition to bars of cartilage. More commonly it may be impossible to identify the nature of atypical glandular structures or undifferentiated epithelium.

In marked contrast to the teratomas, the characteristic appearance of the *seminoma* is its homogeneous consistency. The cut surface is smooth and fleshy, though sometimes areas of necrosis and hæmorrhage may be found (*Fig.* 681). Other specimens present a lobulated appearance, produced by intersecting fibrous septa. Microscopically this tumour is composed of large or medium-sized spheroidal or polyhederal cells, with distinct outlines, clear pale cytoplasm, and round hyperchromatic nuclei (*Figs.* 682, 683). The cells are disposed in sheets or bands and mitotic figures may be numerous. The substrate is a fine fibrillary fibrous tissue separating large or small clumps of cells, and a common finding is the presence of numerous or scanty lymphocytes, associated with the blood-vessels in the septa and between the bands of epithelial cells. In many tumours the cells closely resemble the spermatocytes; in others there is marked anaplasia.

The *chorionepithelioma* is usually a small tumour but may attain considerable proportions (*Fig.* 684).

FIG. 684.—Macroscopical specimen of a chorionepithelioma showing areas of necrosis and hæmorrhage.

It is soft and very liable to necrosis and hæmorrhage, the cut surface often presenting large areas of blood-clot.

Microscopically the growth is composed of continuous syncytial masses of irregular multinucleated undifferentiated epithelium with a substrate of large clearly defined polygonal or round cells with single nuclei—the so-called Langhans cells.

Clinical Features.—

1. *Incidence.*—The disease can occur at any age, and in this series under review the peak age incidence for teratoma was between 20 and 30, and for seminoma a decade higher, that is, between 30 and 40

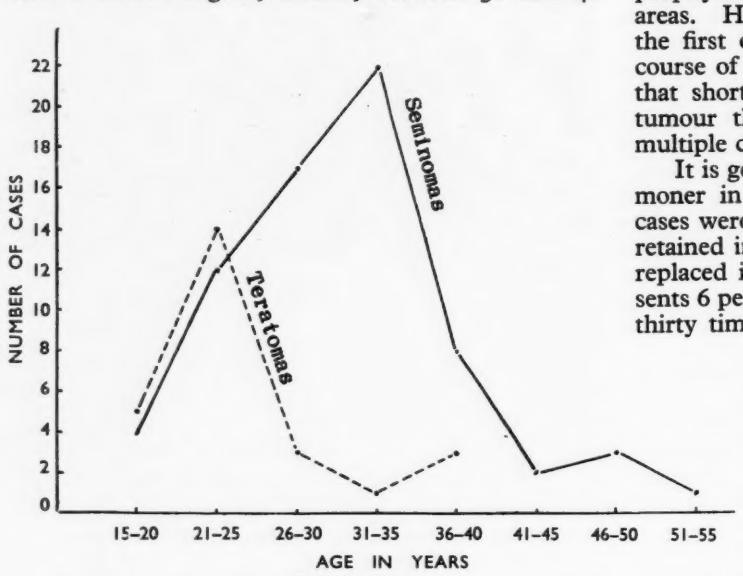

FIG. 685.—Graph showing the age incidence of the two groups of tumours. The peak age incidence for the seminoma is a decade higher than that for the teratoma.

(*Fig.* 685). These figures are in close agreement with most recorded series; thus, Sir Gordon Gordon-Taylor (1947) gave the average age for teratoma as 29 and for seminoma as 39, basing his figures on a series of 688 cases; and Willis (1948) gives the average for teratoma and seminoma as 28 and 43 respectively.

The youngest in our series was a teratoma in a boy of 19, and the oldest a teratoma in a man of 58, but a teratoma has been reported in an infant of only 5 months, and a seminoma in a man of 80 (Gordon-Taylor, 1947). In this connexion it is important to note that whereas seminoma practically never occurs in childhood, teratomas do, and are known to have been present at birth (Wakeley, 1938; Willis, 1948).

Rarely it happens that both testes become the site of disease in one individual; only 63 such cases have been reported in the literature (Pierson, 1932; Parker, 1938; Lewis and Priestley, 1938; Graves and Lawrence, 1942; Sir Gordon Gordon-Taylor, 1947). One such case occurred in the Westminster series, a soldier aged 25, who while serving in India, in June 1942, developed a hard painless slowly growing swelling of the left testis. It gradually increased in size, until it reached the dimensions of a small orange, when he went to his medical officer. A left orchidectomy was performed by Mr. Frank d'Abreu a week later. Histology showed the cause of the swelling to be a seminoma. He had no evidence of metastases in the lungs, abdomen, or elsewhere, but a course of high-voltage irradiation was delivered to the iliac and para-aortic glands in September, 1942, in Bombay.

He remained well for five years, when he developed a hard painless swelling in the right testis. He was admitted to Westminster Hospital and a right orchidectomy was performed, again by Mr. d'Abreu. Histological examination showed that this tumour also was a seminoma.

The operation was followed by a course of prophylactic high-voltage irradiation to the gland areas. He is alive and well now, seven years since the first operation and two years since the second course of irradiation. It is of some interest to note that shortly before the development of the second tumour this man had a son who was born with multiple congenital defects.

It is generally held that malignant disease is commoner in undescended testis, and in this series 9 cases were observed, 7 of them where the organ was retained in the abdomen, and 2 where the testis was replaced in the scrotum by operation. This represents 6 per cent of the total in the series, an incidence thirty times greater than that to be expected if retained or ectopic position had no relation to tumour formation, for it has been estimated by Campbell (1942) that the incidence of retained testis in the general population is only 0·23 per cent.

This is an incidence somewhat lower than that reported in other series. Thus Rea (1931) found a retained testis to be the site of new growth in 13·5 per cent of his series, Hinman (1933) in 12·2 per cent, Dean (1935) in 13·5 per cent, Nash and Leddy (1943) in 8·7 per cent, Ahlbom (1947) in 13 per cent, while Sir Gordon Gordon-Taylor (1947) reported it in 11·8 per cent of his cases.

2. *Signs and Symptoms.*—The patient is invariably in good health before the onset of the disease, and very frequently there is a history of trauma. Of the 147 cases reported, 28 gave a history of antecedent injury. Trauma is, however, an unreliable feature, as it is never difficult to connect any part of the body with some antecedent injury. Gradually increasing, sometimes painful, testicular enlargement, is the commonest symptom, and in the majority it is the earliest manifestation of the disease. It occurred in 135 of the cases reported here, and in these it was the first symptom. Sometimes the progress of the disease is very rapid, and multiple metastases in the para-aortic glands and lungs appear while the primary lesion is still small.

Thus a case aged 20, under the care of Sir Stanford Cade, presented with a history of lassitude and loss of weight of only six weeks' duration; this was associated with epigastric discomfort and blood-stained sputum for two weeks before examination, when the right testis was found to be hard and enlarged to twice the normal size, though painless; a large, hard, fixed mass was palpable in the upper abdomen and radiography showed multiple round metastases throughout both lungs (*Fig.* 686). The patient was suffering from the dreaded

chorionepithelioma, and despite orchidectomy and widefield irradiation he developed hæmaturia from metastases in the kidneys, and in less than ten weeks from the first symptom he was dead. This is the 'hurricane' type of growth so aptly named and described by Sir Gordon Gordon-Taylor and Anthony Till (1938).

More commonly, the growth is slow and there is only a gradual increase in size of the testis, with loss of testicular sensation, extending over weeks or months, or even years, and there may be an associated hydrocele. Sooner or later the primary growth

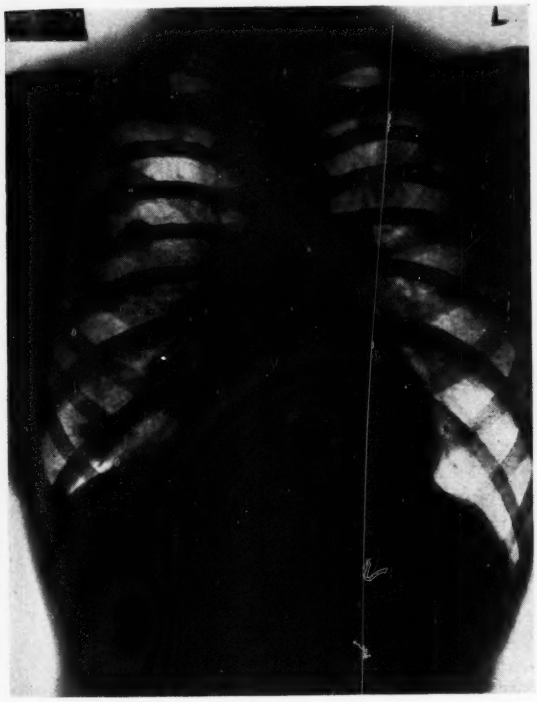

FIG. 686.—Radiograph of the chest, showing multiple round metastases throughout both lungs.

FIG. 687.—Intravenous pyelogram showing the left ureter displaced by enlarged para-aortic glands, the site of secondary deposits from a seminoma of the testis.

increases in size rapidly, and this, together with a mass of secondary deposits in the abdomen (*Fig.* 687) and lungs, heralds an inevitable fatal termination unless treatment is instituted. Rarely the abdominal mass may be the first manifestation of the disease, a very small primary lesion of the testicle only becoming apparent after a careful search. Of course, where the disease occurs in an abdominal testis the mass in the abdomen is the cardinal sign, and should torsion of the diseased abdominal organ occur the case may present as an acute abdominal emergency.

Differential Diagnosis.—It is not the purpose here to discuss in detail the differential diagnosis of malignant disease of the testes, but it is of the utmost importance, when considering lesions within the scrotum, that this condition be kept in mind if early diagnosis is to be made.

Briefly epididymo-orchitis, tuberculosis, torsion of the testes, and gumma are conditions which have to be differentiated from a neoplasm, and associated hydrocele or hæmatocele may obscure the clinical picture.

It is well known that new growths cause early and absolute loss of testicular sensation and that the Aschheim-Zondek reaction may be positive, but exploratory operation and excision of the diseased organ is the method of choice when the diagnosis is in doubt. Nothing is gained by waiting, and excision of a gummatous or tuberculous testis or an organ nonviable from strangulation is a sound therapeutic measure. Biopsy should *never* be contemplated, for it opens the tunica albuginea and allows dissemination of the disease to the scrotum and inguinal glands.

The Significance of Biological Tests.—Not all the cases in this series had biological tests on the urine, therefore in this connexion only guarded conclusions can be drawn. However, it was evident that a negative Aschheim-Zondek or Friedman test was of very limited significance, for in 6 cases with extensive and massive metastases (3 reported as seminoma and 3 as teratoma) this test was negative. Consequently a negative reaction should never be allowed to influence the diagnosis of an enlarged testis which on clinical grounds would be regarded as a neoplasm.

A positive reaction, on the other hand, indicates a grave prognosis. In this series there were 5 such cases (3 reported as teratoma and 2 as chorionepithelioma): 4 did not survive for more than one year, and in the fifth, the test became negative following irradiation.

Incidence and Distribution of Metastases.—Metastases occurred in 74 (or 50 per cent) of the 147 patients in this series; 44 of them had metastases when first seen and 30 developed secondary growths subsequently. The incidence of metastases was highest in the teratomas (34, or 54 per cent, of 63 patients). In contrast, metastatic deposits were less frequent in the seminomas—29 (or 35 per cent)

of 84 patients. The distribution of metastases in both groups is shown in *Table I*.

It is seen that the para-aortic and iliac glands were involved most frequently; they were the site of the disease in 39 cases, i.e., 53 per cent of the cases with metastases had disease in these glands.

Table I.—INCIDENCE AND DISTRIBUTION OF METASTASES IN 74 CASES

SITE	SEMINOMAS	TERATOMAS INCLUDING CHORION-EPITHELIOMAS	FREQUENCY	
			Number	Percentage
Para-aortic and iliac glands	19	20	39	53
Lungs	12	22	34	46
Supraclavicular glands	1	10	11	14
Scrotum and inguinal glands	4	6	10	13
Mediastinum	3	1	4	5
Liver	2	2	4	5
Bones	2	1	3	4
Kidney	1	1	2	2·7
Brain	0	1	1	1·3
Axilla	1	0	1	1·3

Further, they were involved with equal frequency in the two types of neoplasms.

After the para-aortic nodes, the lungs were the commonest site of secondary deposits, then, in order of frequency, the supraclavicular glands, the scrotum and inguinal glands, the mediastinum, liver, bones, and kidneys.

In contrast to the nearly equal frequency of metastases from seminomas and teratomas in the para-aortic nodes, the occurrence of secondary deposits in the lungs was nearly twice as common from teratomas as it was from the seminomas.

Treatment.—Since irradiation was first used in the treatment of malignant disease of the testis by Beclère in 1905, its employment has increased until now its importance overshadows all other therapeutic measures.

In 1938 Sir Gordon Gordon-Taylor, having discussed the various forms of treatment, recommended simple orchidectomy and X-ray therapy as the method to be preferred, and Sir Stanford Cade, writing in 1940, said that unquestionably this was the method of choice, but in 1948 Sauer and his co-workers emphasized the need for reports of cases treated by the three methods—namely, simple orchidectomy, plus irradiation, and radical orchidectomy with and without irradiation; and while freely admitting that irradiation should be used in *all* cases they recommended that the radical operation still had a place in the treatment of radio-resistant testicular tumours.

Whatever the method of treatment employed, consideration of the distribution of the lymphatics is of paramount importance.

The work of Jamieson and Dobson (1910) and of Handfield-Jones (1924) has shown that the lymphatic vessels from the testes drain not only into the para-aortic glands, but also that there is a direct communication from the testes to the internal iliac glands. They have further shown that there is free communication between the primary para-aortic glands on both sides, which in turn link with the glands behind and between the two great vessels above and below the renal veins as well as with the chain above and lateral to the common iliac artery, thus forming what is virtually a large abdominal lymphatic lake (*Fig.* 688).

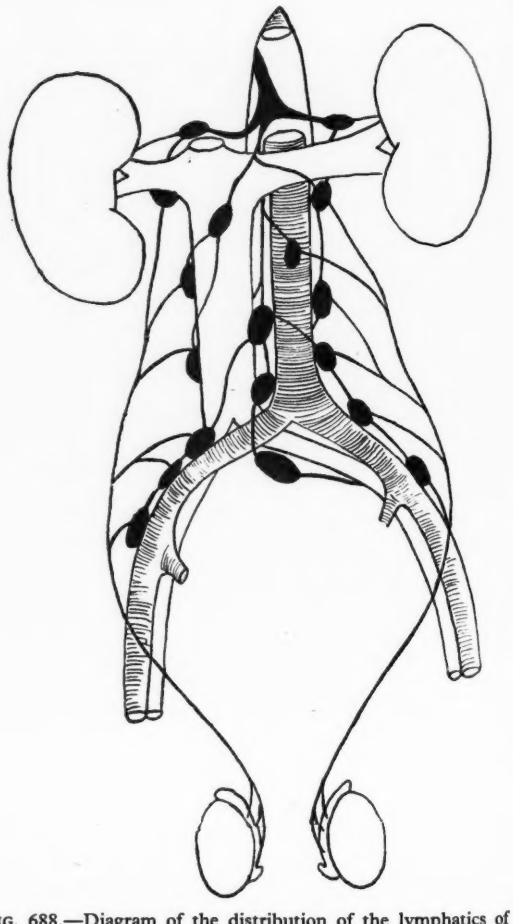

FIG. 688.—Diagram of the distribution of the lymphatics of the testis.

It is clear that if the radical operation is to be justified it must be feasible, without injury to vital structures, to excise all the glands receiving vessels direct from the testes in one block. The only adequate method of doing so would be to remove the retroperitoneal connective-tissue, in which the glands lie, from the level of the renal veins to the termination of the common iliac artery. In other words, the aorta, vena cava, common and internal iliac vessels, the origin of the inferior mesenteric artery, and the spermatic vessels on either side would have to be stripped of the connective tissue and glands lying on, between, and around them. Even if this were possible it must be conceded that there is grave risk of rupturing the delicate lymphatics which are firmly attached to the peritoneum and to the great vessels, thus seeding the wound with malignant cells.

These facts not only dictate the fields to be used in the treatment of the disease, by post-operative prophylactic irradiation, but at the same time render the complete removal of the lymphatic drainage area from the testes an extremely difficult, if not impossible, procedure. Indeed this is confirmed by the end-results of the so-called radical operation, which even in Hinman's (1933) hands gave a five-year survival of only 17 per cent. Thus as a direct result of the widespread dissatisfaction with the end-results of the radical operation, and the sensational improvement in the control of the disease by irradiation, together with the better appreciation of the natural history of the disease, the radical operation has been abandoned.

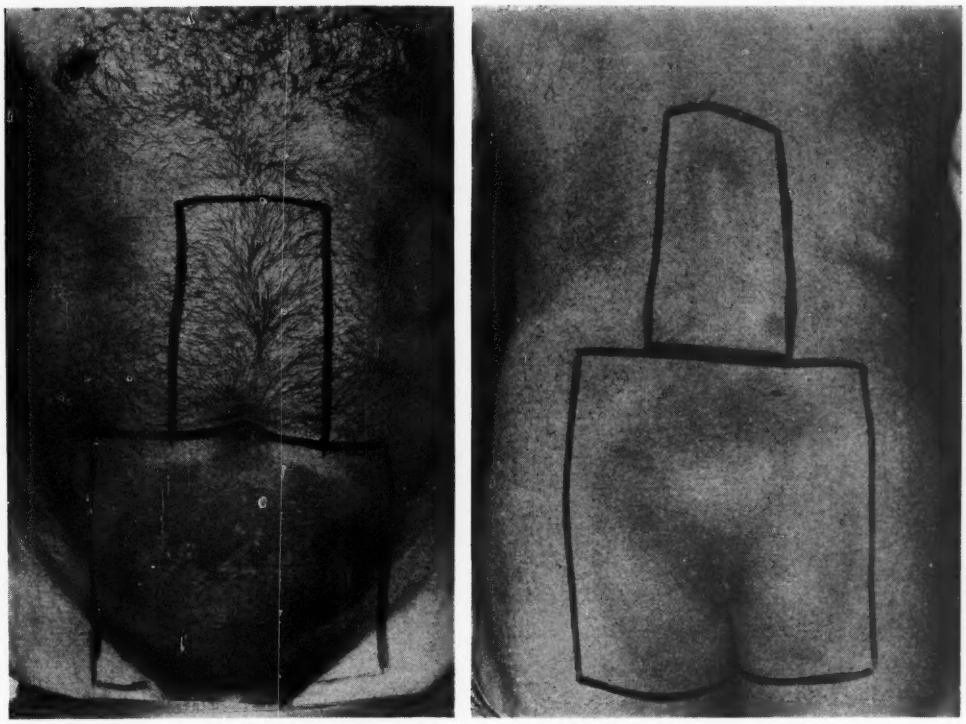

FIG. 689.—Photograph of the irradiation fields marked on a patient.

It has not been found possible yet to forecast which of these tumours are radio-sensitive and which are not. Certain it is that all the seminomas are not radio-sensitive, nor are all the teratomas radio-resistant.

In the series under review all the cases, with the exception of those which presented with an inoperable abdominal mass due to disease in a retained testis, and which were treated by irradiation alone, were treated by surgical removal of the diseased testis, and spermatic cord as far as the internal abdominal ring, and this was followed by prophylactic irradiation to the whole of the lymph-drainage area (para-aortic and iliac glands).

Where the tumour was found at operation to have transgressed the tunica albuginea the inguinal glands were also treated by irradiation.

The majority of the cases have been treated by X rays generated at 220 kv. and 20 ma., with a H.V.L. of 2·2 mm. of copper and F.S.D. of 50 cm. The lower para-aortic and iliac glands are first treated by two opposing 20 × 20 sq. cm. fields, and 2500 to 3000 r is delivered in 30 days (*Fig.* 689).

Six weeks later the upper para-aortic glands are treated through two opposing 15 × 10 sq. cm. fields.

Those cases with metastases in the supraclavicular fossa or in the inguinal glands have been treated with the 4-g. teleradium unit, and in 12 of the earlier cases in the series teleradium was also used for the abdominal metastases, either alone or in combination with X rays.

It is well known that the metastases from a seminoma are very radio-sensitive, so much so that even when there are widespread secondary deposits the disease can be controlled. This is well illustrated by the following case :—

A male, aged 46, under the care of Mr. E. Stanley Lee, had a right orchidectomy in December, 1941, for a histologically proved seminoma of the testis, which had been present for eighteen months. At the time of operation there was also a large hard fixed mass in the epigastrium and right hypochondrium. This was treated by high-voltage X rays and disappeared completely. He remained well for three years, when the left supraclavicular glands were noticed to be enlarged and growing rapidly. These were treated with the 2-g. teleradium unit, and also disappeared completely. He remained well for a further three years, when recurrence appeared, this time in the mediastinum. This also disappeared after treatment with X rays, but six months later the disease recurred for a third time, now in the right iliac fossa. It also was treated with X rays and this man is alive and symptomless now, nine years after his orchidectomy, and a year since his last recurrence.

What is perhaps not so well appreciated is the fact that a considerable proportion of teratomas are

also very radio-sensitive, and that a high proportion of cases seen with multiple metastases may be given long periods of remission by irradiation.

The following is an example of such a case :—

A male, aged 58, under the care of Sir Stanford Cade, had a left orchidectomy in December, 1936, for a histologically proved teratoma of the testis. This was not followed by prophylactic irradiation, and in April, 1939, a large mass appeared in the pelvis. This was treated with high-voltage X rays, and disappeared completely.

FIG. 690.—Radiograph of the chest, showing enlarged mediastinal glands and a mass in the right upper zone of the lung, with destruction of the 4th right rib.

In June, 1940, he reported again with a large hard fixed mass, now in the para-aortic glands. This also was treated with high-voltage X rays and also completely disappeared. In January, 1941, a second recurrence appeared in the pelvis. It was again treated with high-voltage irradiation, and it also disappeared. This patient is alive and symptomless now fourteen years after his orchidectomy, and nine years after his last recurrence.

So far it has been found impossible from clinical and histological examination to state which of the teratomata are radio-sensitive and which are not, and therefore we submit that none should be denied the benefit of prophylactic irradiation.

It is generally held that malignant change in the abdominal testis carries a worse prognosis than tumours in the normal organ, because in these cases the disease has usually advanced far before any suspicion is aroused. Nevertheless, it can be controlled. Thus in the series under review 7 such cases were observed. All presented with hopelessly inoperable abdominal masses, and were treated with X rays only. Three of them are alive and symptomless now, one for 7 years, one for 4 years, and one for 3 years.

One of these cases is of interest, for it illustrates well the control of metastases in bone and in the mediastinum, by irradiation.

A lorry driver, aged 33, under the care of Dr. F. M. Allchin, presented in March, 1946, with pain in the abdomen. He had been operated upon elsewhere five years previously for a left undescended testis which had not been brought into the scrotum. On examination there was a large hard, fixed mass extending upwards from the operation scar and filling the left side of the

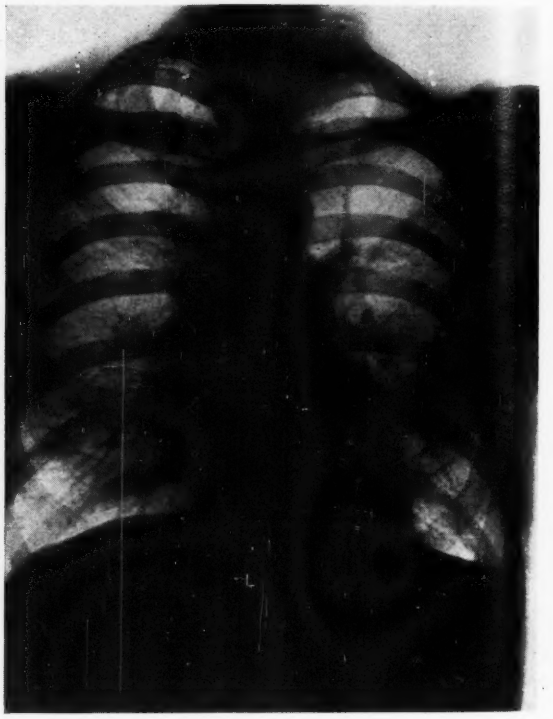

FIG. 691.—Radiograph of the same case as in *Fig.* 690, two months after treatment by irradiation.

pelvis. The para-aortic glands in the left side were enlarged, hard, and fixed. He was treated with high-voltage X rays, and the mass disappeared. The patient remained well for a year and then developed a large mass of glands in the mediastinum associated with secondary deposits in the apex of the lung on the right side, and destruction of the fourth right rib. Irradiation brought about disappearance of the mediastinal mass and pulmonary deposits, and regeneration of the rib. (*Figs.* 690, 691). He remained well for a further eighteen months, and then developed metastases in the body of the twelfth dorsal vertebra. This also was treated with high-voltage X rays. This man is alive and symptomless now, four years since he was first treated, and eighteen months since his last recurrence.

Analysis of Material (147 patients).—The cases in our series have been divided into two groups :—

1. Those which were treated by high-voltage X rays before there was any clinical evidence of metastases in the para-aortic glands, lungs, or elsewhere—that is, prophylactic irradiation (103 cases).

2. Cases which came in the first instance with metastases in the para-aortic glands, lungs, or elsewhere (44 cases).

The five-year survival rate has been estimated in both groups, on the cases seen between 1930 and 1945.

In the first group 57 were seen before 1945 and are therefore available for analysis. Of these, 48 were reported as seminomata and 9 as teratomata. Of the 48 cases of seminoma, 32 are alive and symptom-free now, representing a 66 per cent five-year symptom-free survival. Of the 9 cases reported as teratomata, 5 are alive and symptom-free now, i.e., 55 per cent five-year symptom-free survival.

In the second group, that is those presenting for the first time with metastases, 33 cases were treated between the years 1930 and 1945 ; 10 were teratomata and 10 seminomata, and in 13 there was no histological proof. Five are alive and free from disease five or more years since the beginning of treatment. This represents a five-year symptom-free survival of 15 per cent.

It is seen, therefore, that if metastases are already present when the patient is first examined, the prognosis, as might be expected, is considerably worse, but it is not entirely hopeless if irradiation is given, for 15 per cent of the patients in the series at Westminster Hospital are alive after five years, a not unsatisfactory achievement.

SUMMARY

1. A review of 147 cases of malignant disease of the testes treated at Westminster Hospital is presented.

2. The cases are classified as seminoma, teratoma, or chorionepithelioma. This is justified on clinical grounds by the age incidence and the prognosis.

3. The histological type of the tumour, the treatment employed, and the stage of disease have an important bearing on the prognosis.

4. Metastases occurred in 50 per cent of the cases. The incidence was highest in the patients with teratoma (54 per cent), and lowest in those with seminoma (35 per cent). While metastases from both groups occurred with equal frequency in the abdominal lymph-nodes, it was found that secondary growths in the lungs were twice as common in patients with a teratoma as in those with seminoma.

5. Simple orchidectomy followed by irradiation in all cases is recommended as the treatment of choice. Details of irradiation treatment are given.

6. The prognosis is best in those cases of seminoma treated before there was clinical evidence of metastases—thus, 66 per cent of such cases are alive and free from disease five or more years after treatment. It is less favourable in patients with teratoma, but 55 per cent of patients without metastases when first treated are alive and well for the same period.

The prognosis is much more unfavourable in those cases which present in the first instance with metastases present, but 15 per cent of these cases are free from disease five years after treatment by irradiation.

I have to thank Dr. F. M. Allchin and my colleagues at Westminster Hospital for permission to make use of the case records ; Dr. George Lumb for reviewing the histology ; Dr. Peter Hansell, of the Photographic Department, Westminster Hospital ; and Mr. Hennell, of the Photographic Department of the Metal Box Company Ltd. My especial thanks are due to Sir Stanford Cade, who collected the majority of the cases, and who has given me invaluable advice in connexion with the views I have expressed.

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ACUTE RENAL FAILURE

TWO CASES TREATED BY DECAPSULATION AND PERITONEAL DIALYSIS

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Acute renal failure in previously normal kidneys is a well-recognized complicating factor of certain traumatic or toxic processes, such as incompatible blood transfusion, crush syndrome, sulphonamide and other drug intoxication, severe burns, and intravascular hæmolysis following transurethral operations.

That a similar clinical and pathological picture can be produced by such a diversity of causes suggests a common mechanism.

Recent discussion (Black and Stanbury, 1948) indicates that this common mechanism is probably a combination of renal vasospasm, producing a redistribution of renal blood-flow with emphasis on the less efficient medullary nephrons (Trueta, 1948), and, secondly, tubular degeneration and blockage affecting particularly the distal convoluted tubules.

The cortical ischæmia subsequent to vasospasm accentuates still further the initial tubular damage, and, if allowed to persist, will cause irreparable harm to both kidneys and inevitable uræmic death.

If the above explanation is true then recovery in these cases would be heralded by a resumption of normal blood-flow through the cortex, with restoration of tubular function.

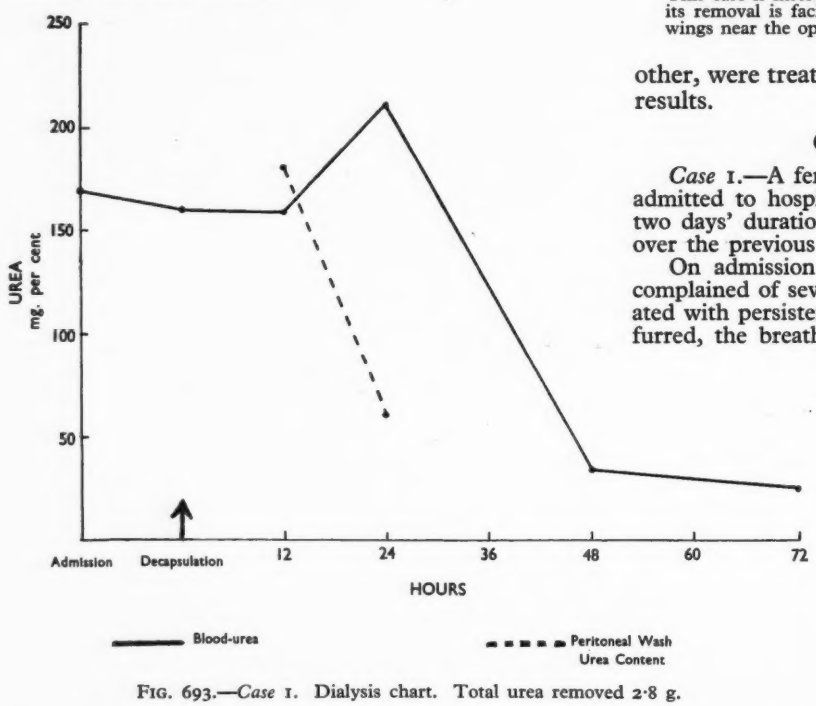

Fig. 693.—*Case* 1. Dialysis chart. Total urea removed 2·8 g.

Treatment is thus aimed at :—

a. Establishing patency of the normal channels beyond the tubules.

b. Correcting the cortical ischæmia.

c. Providing an alternative route for the removal of waste products of metabolism until renal function is restored.

d. Conserving blood-electrolyte, particularly chlorides, as soon as diuresis commences.

The following cases of acute renal failure, precipitated by sulphonamide in one and aspirin in the other, were treated on the above lines with successful results.

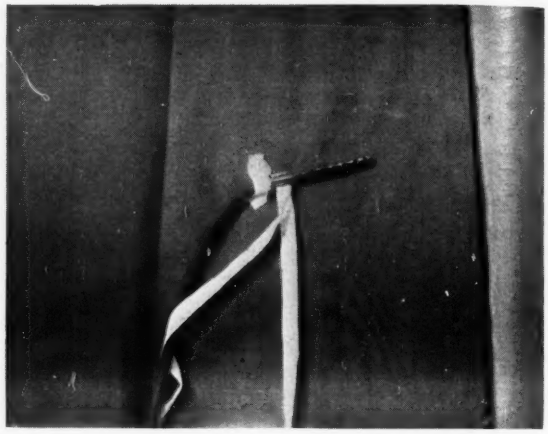

Fig. 692.—Photograph of the perforated aluminium thermometer case used for the purposes of peritoneal dialysis. This case is inserted completely into the peritoneal cavity and its removal is facilitated by the tapes attached to the narrow wings near the open end.

CASE REPORTS

Case 1.—A female patient, S. T., aged 14 years, was admitted to hospital on Sept. 30, 1949, with anuria of two days' duration, having had 18 g. of sulphamerazine over the previous five days for an attack of tonsillitis.

On admission the patient looked extremely ill and complained of severe right-sided abdominal pain, associated with persistent vomiting. The tongue was dry and furred, the breath decidedly uræmic, and both kidneys were markedly tender to palpation. Catheterization produced 1 oz. of blood-stained urine containing tubular epithelium, granular casts, and numerous needle-shaped crystals of a sulphonamide derivative. The blood-urea was 160 mg. per cent. Cystoscopy the same day revealed blood-clot only in the bladder, there being no œdema or hæmorrhage in the mucosa and no evidence of secretion from either kidney. Ureteric catheterization was unobstructed, but 8 c.c. only of blood-stained urine was obtained from the right kidney and 1 c.c. of almost pure blood from the left kidney. These catheters were left in situ after washing out the kidney pelves with a 3·8 per cent solution of sodium citrate. Over the next twelve hours there was no drainage from either catheter and the general condition of the patient became much weaker, with periods of semiconsciousness. Twenty-four hours after admission bilateral decapsulation of the kidneys was performed under general anæsthesia (intratracheal cyclopropane and oxygen—Dr. R. E. Loder). At the same

time a perforated aluminium tube—a thermometer case (*Fig.* 692)—was inserted into the peritoneal cavity below the left kidney and alongside the descending colon for irrigation purposes and a nephrostomy performed on the right kidney. Within six hours the nephrostomy drained almost clear urine and thirty-six hours later the patient passed urine normally.

During the first twenty-four hours after operation the peritoneal cavity was irrigated three times with 2000 c.c. of normal saline, each irrigation spread over approximately seven hours. The returns from the first two

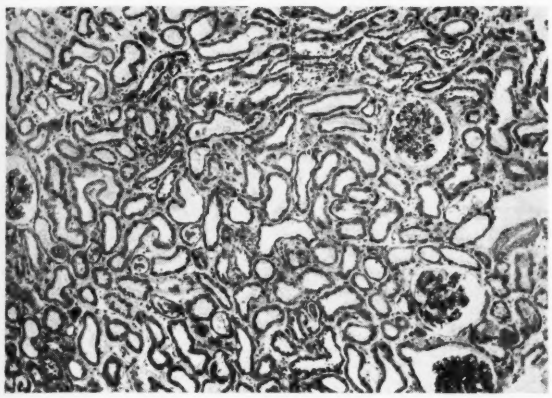

FIG. 694.—*Case* 2. Photomicrograph of kidney cortex, showing ischæmic but otherwise normal glomeruli, degenerated tubules, some filled with debris and thrombi, and œdema of the interstitial tissue.

washings were collected together by mistake and totalled 1430 c.c., with a urea concentration of 180 mg. per cent, whilst the third washing totalled 430 c.c. with a urea content of 60 mg. per cent. Blood-urea estimations in the middle and towards the end of this period were 160 and 220 mg. per cent respectively (*Fig.* 693). Aqueous penicillin, in 300,000-unit doses twice daily, was administered intramuscularly, commencing immediately after the operation, and discontinued when a total of 5,000,000 units had been reached. The patient gave no undue cause for anxiety in the post-operative phase: an intravenous pyelogram on the fourth day showed both kidneys to be functioning, but that concentration of the dye was poor. A specimen of urine on the sixth day contained a trace of albumin and a moderate number of R.B.C.s and leucocytes, with no casts or crystals. The nephrostomy sinus leaked a little urine for fourteen days, after which both wounds remained dry and healed soundly. The patient was now eating well. Her intake and output were normal and she was allowed up, being discharged on Oct. 27, one month after admission. Three months later the patient was found to be perfectly well, with no symptoms, and clinical examination revealed no abnormality.

Comment.—Careful questioning before discharge showed that the patient had not carried out her doctor's instructions regarding adequate fluid intake, it being roughly estimated that over the five days prior to admission, whilst on sulphamerazine, she had consumed 3000 c.c. of fluid only, an average of 600 c.c. per day. Sulphamerazine has the advantage of wider spaced doses and lower individual dose, but gives proportionately higher blood-levels due to higher absorption rate and lower rate of excretion (Welch, Mattis, Latven, Benson, and Shiels, 1943). These authors quote J. A. Shannon in a personal communication as reporting the reabsorption of sulphamerazine to be 95 per cent in the tubules, a higher rate of reabsorption than any other sulphonamide. These experimental findings would suggest that although a more efficient and less toxic sulphonamide has been found, even greater vigilance on adequate fluids during therapy is required in view of the increased onus of reabsorption placed on the tubules.

The decapsulation was carried out via the posterior approach, with the patient in the prone position and the kidneys stripped in situ. The intense congestion of each kidney was very evident and the manner in which immediate expansion took place after stripping strongly suggested that they were under considerable tension.

It was felt that the peritoneal dialysis played only a small part in this patient's recovery in that only 2·8 g. of urea were removed, and, even allowing for the loss in the dressings, the method used in this instance, viz., slow irrigation, did not appear at all satisfactory.

Case 2.—Male, J. S., aged 48, was admitted at midnight on April 23, 1950, in a semiconscious state with a history of having swallowed between three and four hundred 5-gr. tablets of aspirin, in an attempt to commit suicide. He exhibited extreme restlessness, being almost maniacal, and requiring several men to hold him down. He vomited continuously, perspired profusely and before admission to the ward underwent a prolonged epileptiform attack. With considerable difficulty gastric lavage was carried out, removing much undigested aspirin. Catheterization produced 780 c.c. of clear straw-coloured urine, reported as follows: "Reaction neutral, protein trace, reducing substance trace, acetone +++. Deposit, a few R.B.C.s, a few leucocytes, no casts, culture sterile."

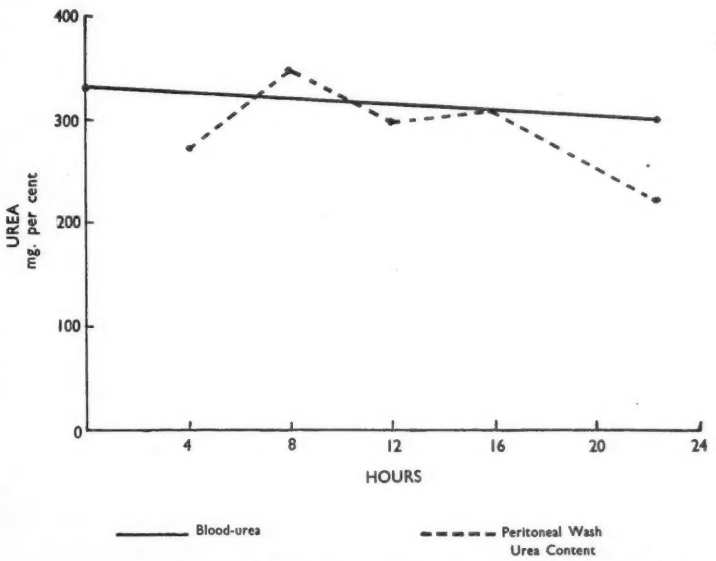

FIG. 695.—*Case* 2. Dialysis chart. The washings were collected in six successive winchesters and the urea concentration of each is recorded. The total quantity of urea removed in this case was 42·909 g.

An intravenous infusion of 5 per cent glucose-saline commenced shortly after admission had to be discontinued after the second vacolitre owing to the patient being almost uncontrollable. The following morning, although quieter, he remained for the most part grossly

irrational. A second specimen of urine was now blood-stained and contained acetone bodies in excess and gave a strong positive reaction for aspirin. The total quantity of urine on the day after admission was 90 c.c., and this oliguria persisted for the next five days, the blood-urea on April 27 being 330 mg. per cent. On the fourth day a spinal anæsthetic, producing skin anæsthesia up to T.4 (Dr. R. E. Loder), had no apparent influence on kidney function. Following this procedure a cystoscopy was performed and revealed an œdematous bladder, its wall studded with hæmorrhages and making identification and catheterization of the ureters impossible.

During these four days he had been kept on a restricted fluid intake of not more than 1000 c.c. per day, and this period was marked by extreme confusion, spells of unconsciousness, and persistent diarrhœa. His blood-pressure on April 27 was 155/90.

On the fifth day of oliguria his condition showed no improvement whatsoever, the blood-urea remained at 330 mg. per cent, and after consultation it was decided that decapsulation should be tried. At all events it was felt that nothing could be lost by this procedure, that recovery might ensue, and that medical treatment had been given a fair trial. Exactly the same operative procedure was carried out as in the first case and it was noticed that both kidneys were under considerable tension and the perirenal tissues contained an appreciable amount of œdematous fluid. Opportunity was taken to secure a piece of the cortex from the right kidney for biopsy (*Fig.* 694). Its extreme pallor was particularly noticeable. On return to the ward he remained in the prone position for 24 hours, during which time intermittent peritoneal lavage was instituted, using two litres of normal saline at a time, a total of 34 litres being run in and 15 litres being obtained by syphonage. This 'wash' contained a total of 42·909 g. of urea and the blood-urea at the end of the period was 300 mg. per cent (*Fig.* 695). As signs of salt retention developed, the peritoneal irrigation was discontinued, atropine gr. $\frac{1}{100}$ and adrenaline were administered and the patient sat up. During the night his condition gave rise to considerable anxiety, but the next morning he passed 180 c.c. of almost clear urine and showed a general improvement. At the beginning of the recovery phase, despite his good urinary output, the blood-urea continued to rise, whilst both plasma-proteins and plasma-chlorides were below normal (*Fig.* 696).

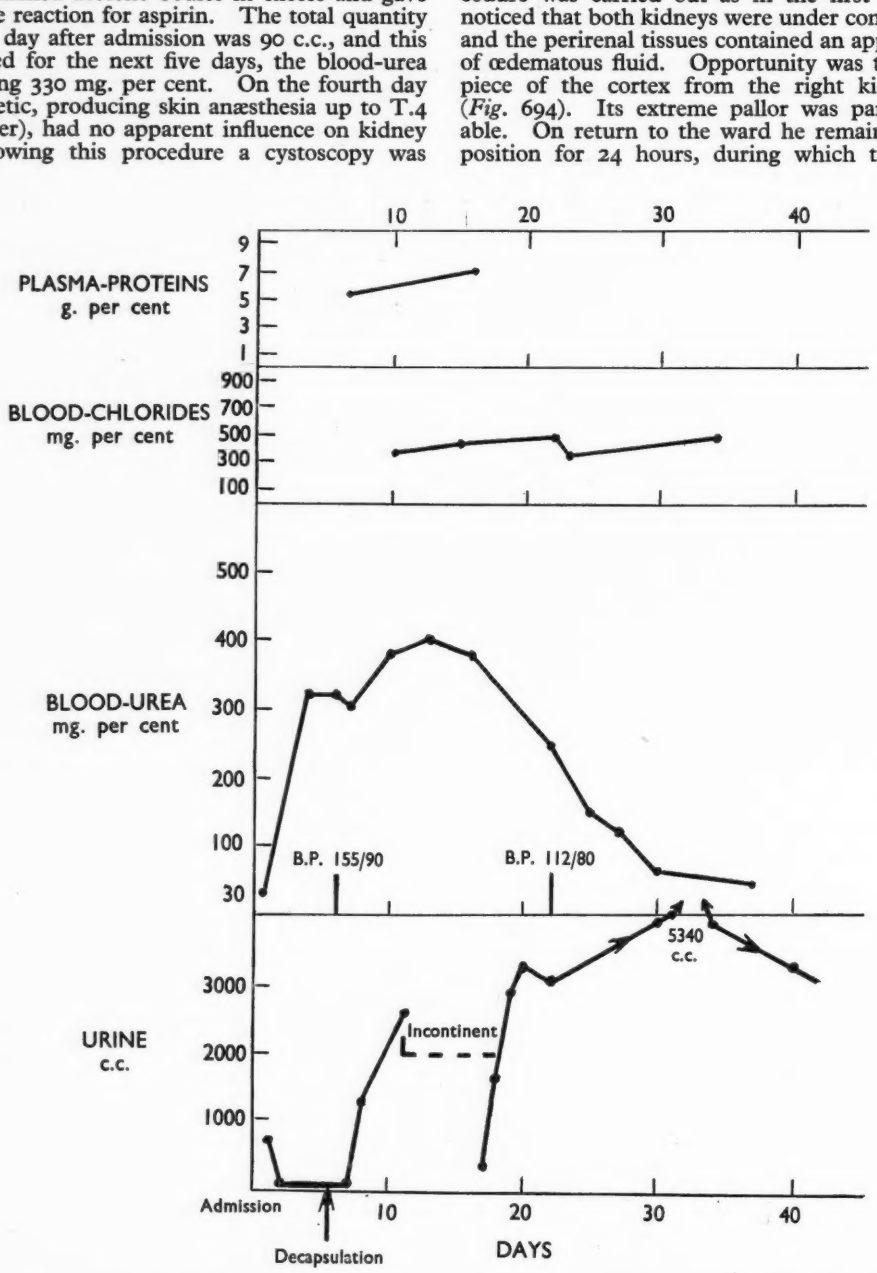

FIG. 696.—*Case* 2. Composite chart showing progress following decapsulation and dialysis. The extreme diuresis subsequent to the secondary rise of the blood-urea is particularly marked. On the thirty-fourth day he passed over 5 l. of urine.

In the second post-operative week he became temporarily incontinent and exhibited marked signs of 'nephritic' tetany, which responded to intramuscular injections of calcium gluconate. Also it was noted that at times he appeared exceptionally dehydrated despite a high oral intake, and it was at these times that he became most confused and irrational. In the third week he regained his normal mental status for the first time since admission. A week later he was allowed up and had commenced physiotherapy for a traumatic peroneal nerve palsy resultant from the enforced measures that were used to hold him in bed at the time of admission. Five weeks after the operation his blood-urea was within normal limits and he was awaiting discharge to convalescence.

Comment.—Leveson (1949), reviewing 48 cases of aspirin suicide, including one where a similar quantity of the drug had been ingested without gross renal upset, comments on the relative rarity of this type of complication in his series. It would appear that, as in some cases of sulphatherapy, the renal damage is an allergic phenomenon and thus unrelated to the quantity of drug ingested. It is, however, felt that the profuse perspiration characteristic of this drug will aggravate any tendency to kidney damage; and it is further suggested that a pointer to possible renal complications in this type of case may be the slightly raised blood-pressure, in contrast to the distinctly low pressure usually found in aspirin poisoning. Leveson quotes a case of Hopkins (1945) where hallucinations occurred, and it is interesting to record that on several occasions this patient went through all the stages of labour in the minutest detail, convinced that he was Mrs. —— and having a little girl. When asked the name, the inquirer was told " you will have to ask my husband ".

A feature of post-mortem findings in these cases is the widespread hæmorrhages on serous surfaces, due to the heparinizing effect of salicylic acid, and this is illustrated in *Fig.* 697 where the hæmorrhages were still present in the bladder wall two weeks after decapsulation.

The post-operative rise in blood-urea in this case (and less noticeably in *Case* 1) is interesting; this feature was commented upon by Shapiro (1948) as follows: " it took the kidneys many days to catch up the work so long left undone "—a brief but seemingly adequate explanation. A further confirmation of secondary renal failure is shown by the occurrence of 'nephritic' tetany in the same period.

DISCUSSION

Welch and others (1943) studied the effects of toxic doses of sulphamerazine and sulphadiazine in monkeys and their autopsy findings in the majority of cases can be briefly summarized as follows: macroscopically, the kidneys were swollen and apparently under considerable tension, whilst microscopically the three most common features were the relatively normal glomeruli, the extensive tubular damage, and finally the frequent incidence of thromboses in the small renal veins. Darmady (1947), in discussing cases of the traumatic uræmia syndrome, describes similar macroscopic and microscopic findings with, in addition, tubulovenous ruptures which may or may not be associated with venous thrombosis, and which occurred most frequently in the boundary zone.

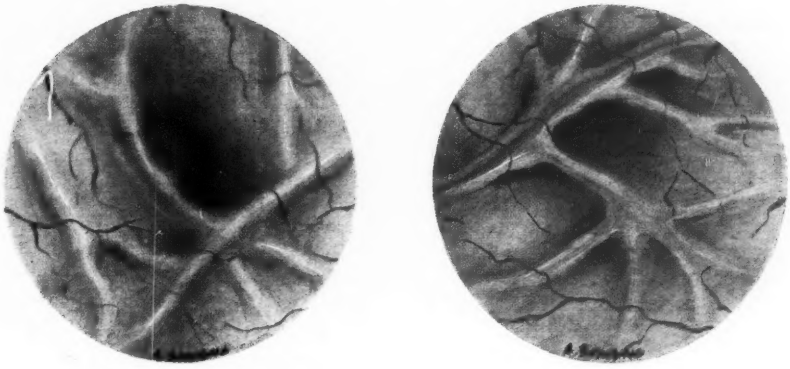

FIG. 697.—*Case* 2.—Cystoscopic appearances two weeks after admission. Showing hæmorrhage in bladder mucosa.

Darmady favours the theory of vasospasm as being the primary cause of renal damage in this syndrome, the spasm being initiated reflexly through either the splanchnic or peripheral nerves. A similar shunt of the circulation in an organ has been shown to occur in the stomach as a result of reflex stimulation (Barclay and Bentley, 1949). In both instances interruption of the sympathetic pathways will reverse the process. Consideration of this response of the vascular channels of vital organs in answer to trauma or toxins reveals that the shunt is probably a protective mechanism in the first instance actively employed by the body tissues to prevent damage to the specialized cells of the organ concerned. In the case of the kidney the glomeruli are to a certain extent protected by the relative cortical ischæmia in the early stages. If this vascular shunt continues as a result of further nocuous stimulation, then the cortical ischæmia leads to cortical necrosis and thus irreversible damage.

Trueta (1948) has demonstrated the vascular shunt in rabbits, the redistribution resulting in the main flow of blood being directed through the juxtamedullary glomeruli, with subsequent ischæmic changes in the cortex. On the other hand, it has been suggested by Himsworth (1948) that the swelling of the renal parenchyma *per se* will compress the cortex and so divert the flow of blood towards the medulla.

Whilst no one would deny the part played by the tubular damage towards suppression of urine, the vasospastic element has been criticized mainly on the grounds that cases of this type of renal failure have not always responded to splanchnic block or spinal anæsthesia. A possible explanation of this lack of response is put forward shortly. In support of the theory of vasospasm the writer suggests that a vicious circle is set up in that the cortical glomeruli, being rendered ischæmic by the vasospastic shunt, cause the blood-pressure to rise in an effort to open them up for the purposes of filtration. If, however, the shunt continues, as it will do in the type of case under discussion, then the effort fails and the brunt of raised blood-pressure falls on the juxta-medullary zones which are already congested and in some instances partially blocked by venous thromboses. The main outcome is, therefore, a general increase of intrarenal pressure or tension which still further compresses the cortical glomeruli. The operative findings in these two cases and others recorded in the literature and summarized below confirm the fact of increased tension and the benefit of decapsulation. The part played by the latter procedure is almost purely mechanical, lowering pressure on the cortex in readiness for the restoration of normal flow at the cessation of vasospasm. Autopsy findings in animals or human beings who have survived for longer periods of acute renal failure reveal a small kidney with a wrinkled cortex, suggesting that in the later stages the necrotic cortical glomeruli fail to stimulate the blood-pressure reflexly and therefore tension drops. It is in these delayed cases that decapsulation fails, and it is contended that to be of value decapsulation must be carried out in the early stage of acute renal failure, before continued renal anoxia has led to necrosis.

Ashton Miller (1949), in discussing decapsulation, quotes three cases, the first showing at operation and autopsy massive necrosis of the cortex, the decapsulation having been carried out on the fifth day of anuria. The second case was decapsulated on the seventh day of complete anuria, there being no note of the condition of the cortex recorded. It is suggested that both these cases had reached the irreversible stage of renal failure and were doomed anyway. The third case, one of advanced uræmia due to chronic nephritis, falls into the large group of renal failure syndromes where it is freely admitted that decapsulation, or indeed any measure, has no real value.

The following are extracts of cases recorded in the literature, briefly indicating the operative findings and authors' opinions :—

Weinstein and Adams (1943) : Sulphathiazole anuria of three days' duration. At decapsulation " the kidney cortex was seen to puff out under a tight capsule . . . he urinated shortly after the operation . . . leaving little doubt that the operation was directly responsible for saving his life ".

Fletcher (1941) : Sulphapyridine anuria of three days' duration . . . " it was decided that decapsulation of the kidneys offered the only chance of survival . . . on exposure the kidneys were found to be enlarged, lobulated, and œdematous . . ." The patient died the next day without urinating.

K. Lewis (1944) : Sulphapyridine anuria . . . " after five days in which only 3 oz. of urine had been passed . . . the operation was decided on and the right kidney was exposed. The renal pelvis appeared œdematous, but not distended, and the kidney was enlarged . . . the renal capsule was therefore stripped and the pelvis drained . . . eight hours after operation the dressings were soaked in urine. Intravenous pyelograms showed that the right kidney functioned well, but concentration of the dye in the left kidney was slightly reduced ".

Wattenberg and Coleman (1943) : Sulphathiazole anuria of five days' duration treated by unilateral decapsulation . . . " the tissues were markedly œdematous and swollen in appearance . . . as the capsule was removed the kidney was seen to expand in size . . . within a few hours the dressings were saturated with urine ".

Marquardt, Cook, and Frederich (1944) : *Case* 1. Transurethral resection of prostate followed by three days' anuria . . . " it was then arbitrarily decided to decapsulate the right kidney, a nephrostomy was also done and before the patient left the operating table urine was flowing freely from the nephrostomy tube. The perirenal tissues were found œdematous, the kidneys were congested and under tension. This proved a life-saving measure in this patient, for his unoperated kidney did not secrete urine until the fifteenth day after his transurethral resection. Indigocarmine tests showed that the undecapsulated kidney did not become the functional equal of the decapsulated kidney till the twenty-sixth hospital day ".

Case 2. Bichloride of mercury poisoning : 49 hours after anuria occurred . . . " a right decapsulation was done . . . the capsule was somewhat under tension and the kidney was congested ". Two days later the left kidney was decapsulated and the urinary output became normal, but the child died of multiple bowel perforations ten days later . . . " it is reasonable to assume decapsulation of her kidneys was a life-saving procedure and had not peritonitis supervened a complete recovery might have occurred ".

Skibba (1944) : Sulphathiazole anuria of two days' duration treated by unilateral decapsulation . . . " the right kidney . . . was increased in size . . . and on incising the capsule a moderate amount of kidney cortex bulged out ". The patient passed 355 c.c. of urine the next day.

Reid (1946) : Incompatible blood transfusion, anuria of nine days' duration, decapsulation on the tenth . . . " the capsules seemed very tense and pale blue friable kidney bulged through the line of incision owing to increased intracapsular pressure . . . the left kidney almost exploded ". Approximately 36 hours later urination took place normally. The author states further : " We think that in our case none of the procedures adopted before decapsulation had any beneficial effect and that the operation was justified by the subsequent diuresis. The expansion of the kidney following the section of the capsule was most impressive and suggests that the relief of tension was an important factor in renal recovery ".

Shapiro (1948) describes two cases of sulphathiazole anuria, one of three and the other seven days' duration. The findings were similar in the two cases : " First was the enormous œdema of all the tissues . . . second was the markedly swollen tense condition of the kidneys. They were a dark red cyanotic colour and with the first nick of the capsule by the scalpel there was marked bulging of the underlying tissue. The kidney was extremely friable . . . decapsulation carries with it practically no primary mortality and can be rapidly performed under local or regional anæsthesia with comparative safety even in a very toxic individual. Delay can only lessen the opportunity of the kidneys to return to normal function." In both cases urination occurred within twenty-four hours of decapsulation.

Kleiman (1946) reports on sulphathiazole anuria of five days' duration treated by unilateral decapsulation : " The kidney was enlarged to about one and three-quarters its normal size. It was very turgescent. The

capsule was under undue strain, when it was nicked the kidney practically decapsulated itself." Urination occurred the following evening. Three weeks after, intravenous pyelography showed that the untouched kidney failed to concentrate the dye after thirty minutes and there was no excretion of indigocarmine at sixty minutes from that kidney, whereas the decapsulated showed normal results to both these tests. " It must be assumed that the constricting effect of the capsule plus the toxic reaction on the involved kidney had so impaired renal function that for all practical purposes the right kidney is at present (three weeks post-operatively) a non-functioning organ. To the author, this proves conclusively that the renal decapsulation was a life-saving measure."

The foregoing extracts and the findings in the cases here presented seem to indicate that the act of stripping a kidney restores function where this has been depressed by tubular damage and vasospasm. From the anatomical viewpoint the true capsule of the kidney is in fact split in the operation of decapsulation. This splitting occurs through the middle layer, this being one of loose areolar tissue containing the communicating vessels between the outer coat of fibrous and elastic tissue, and the inner coat of loose muscle-fibres containing the subcapsular vessels and forming the innermost boundary zone to the true cortex. Although both the outer and inner layers of the capsule are capable of expansion, operative findings prove that the inner layer is capable of greater expansion but is held back by the outer layer. It is the inner layer of the capsule, with its cyanotic distended blood-vessels, which accounts for the typical colour found at operation. Biopsy reveals beneath this layer the very pale cortex which confirms the ischæmia resulting from the vascular shunt. The cyanotic condition of the inner layer is produced by the delayed venous return consequent on thromboses in the medullary zone, and its congestion is due to reflexly increased blood-pressure.

As only a small fraction of the kidney is working at any one time, it follows that in these cases of acute renal failure only a small proportion of the glomerular systems bear the brunt of damage on their associated tubules, and this damage initiates the vasospasm affecting the kidney as a whole. Both the glomerular afferent arteriolar spasm and pressure caused by the congested inner layer of the true capsule produce and aggravate the cortical ischæmia which endangers the vitality of glomerular systems not primarily damaged.

Relief of vasospasm may occur spontaneously or follow sympathetic paralysis, and thus renal function is restored. It is not difficult to imagine that even if vasospasm ceases or is otherwise interrupted the initial venous thromboses and the raised intrarenal pressure may be so severe as to prevent the flow of blood into the now relaxed glomerular systems. It is in this type of case where there is no response to paralysis of the sympathetic that the mechanical process of decapsulation may succeed. Where this procedure fails to restore function, autopsy will usually reveal cortical necrosis, which may occur after only three days of anuria (Fletcher, 1941). It would thus seem that the onset of cortical necrosis is an individual matter dependent on the ability or otherwise of the glomerular systems to withstand a protracted anoxia. Bull, Joekes, and Lowe (1949) strongly favour the conservative treatment on special diet and report successful results, even after three weeks' anuria. With the knowledge of the pathological changes that occur after three or four days' anuria, one hesitates to surmise how much of the reserve of the kidney has been permanently ablated by such a long period of anoxia. In the writer's view the great advantage of decapsulation lies not in the rapid elimination of uræmia but in reversing the state of anoxia and thus resuscitating glomerular systems as yet undamaged by persistent vasospasm. That the degree of uræmia as indicated by the blood-urea may not be radically altered for three weeks after the onset of anuria is shown in *Case* 2, but it is emphasized in favour of decapsulation that for the second two weeks of this period the kidneys were oxygenated and the glomerular systems working, even if, owing to defective epithelium, the tubules were not reabsorbing properly.

In the conduct of these cases of acute renal failure or lower nephron disease (Lucke, 1946), one does not contest the ever-present possibility of spontaneous diuresis, but in face of continuing oliguria or anuria and gradual deterioration of the general condition, one hesitates to delay too long a procedure, in itself not difficult, as yet to be proved harmful, and in many cases almost instantaneously gratifying in its results, so that coincidence is readily discounted by even the most conservative of those who witness the dramatic change.

Peritoneal Dialysis.—In the suppression phase of these two cases opportunity has been taken to utilize the peritoneum as a dialysing membrane to rid the blood-stream of the waste products of metabolism. With an area of 6 sq. m. it compares favourably with the total glomerular area of 3 sq. m. (Vimtrup, 1928), and it has been satisfactorily established that the blood can be cleared of urea by the peritoneum with about 50 per cent of the efficiency of the kidneys (Fine, Frank, and Seligman, 1946). Homer Smith (1943) has estimated the flow of blood through the kidneys as 1300 c.c. per minute, which in the normal person would clear 20 mg. of urea or 30 g. in twenty-four hours.

In *Case* 1 2·8 g. of urea were removed via the peritoneal cavity and in *Case* 2 42·9 g. In neither case does the writer think that this procedure really helped in recovery. At the present time peritoneal dialysis is still in the experimental stage and Reid (1948) has tried various solutions, emphasizing the value of intermittent injections, and he records that 5 per cent glucose in normal saline appears to be the most satisfactory. In general his technique, using different solutions, was to run in quickly or slowly a maximum of two litres at a time and then allow this quantity to be retained for varying periods up to twelve hours.

It appears that any method of dialysis via the peritoneum is subject to the following drawbacks:

1. The quantity withdrawn seems never to equal the quantity instilled, even allowing for wastage in the dressings.

2. Adhesions and reactionary or pyogenic peritonitis will cause loculations and lessening of the surface available for dialysis.

3. It appears to be a biochemical problem of some magnitude to constitute an irrigating fluid which

will extract the maximum quantity of unwanted substances from the blood-stream with minimum disturbance to the normal levels of the normal constituents. Darmady (1948) quotes Campbell as having confirmed the fact that the osmotic pressure of uræmic plasma is raised and, further, that glucose in the dialysing fluid will diffuse into the blood-stream, causing a water shift. This would suggest that an electrolytic solution similar to the electrolytic constitution of plasma and containing glucose is not necessarily the ideal fluid to use in peritoneal dialysis.

It was felt that, after treating the first case, should the opportunity arise again, then peritoneal dialysis would be employed with two principles in mind, viz. : (*a*) A simple solution should again be used. Normal saline, as in *Case* 1. (*b*) This solution should be run in rapidly and as rapidly removed, with no interval between cessation of installation and the start of evacuation.

Normal saline would be used because the only absorption that could then take place would be either water and/or salt, the former of which it was judged the body would deal with as soon as kidney function was restored, and the latter, owing to tubular damage and little or no reabsorption in the diuresis phase after the return of glomerular filtration, would be excreted in any case. In fact, once the kidneys commence to function then salt retention or excess is extremely unlikely.

The solution would be run in rapidly and as rapidly removed because it has been satisfactorily demonstrated that urea diffuses rapidly (within two hours), reaching a concentration higher, possibly, than that in the blood-stream (Reid, 1948). With this in mind there does not seem any point in leaving the fluid in the peritoneal cavity beyond the time taken to run it in, i.e., one hour. Similarly rapid installation and evacuation would also diminish the quantity of electrolyte lost from the blood-stream into the peritoneal lavage.

Thus in *Case* 2 evacuation by siphonage took a matter of two or three minutes and during the twenty-four hour period following decapsulation 34 litres of normal saline were instilled in seventeen intermittent injections of 2 litres each. It will be noticed from the graph (*Fig.* 695) that the quantity of urea cleared per unit time began to fall off towards the end of the period, when it was also noticed that the filling and emptying of the peritoneal cavity was slower than at first. During the period of peritoneal lavage the patient was nursed in the prone position. Accounts in the literature of this procedure not infrequently mention the loss in the dressings of irrigating fluid. It is presumed that if the patient is nursed in the prone position and the fluid removed by siphonage then any fluid loss must inevitably be due to overfilling of the peritoneal cavity. Obviously one of the major factors affecting the cubic capacity of the peritoneal cavity will be gas content of the bowel, and thus it may be helpful to precede the dialysis by an enema and leave a flatus tube in situ during the lavage. Finally, loss of urea in the dressings will be minimized if the rapid instillation and evacuation method is adopted.

SUMMARY

Two cases of renal suppression treated successfully by decapsulation are described and the mechanism is discussed.

It is submitted that decapsulation, by removing the outer limiting layer of the true capsule, allows the cortex to expand within the inner muscle layer and so relieve the anoxia consequent on circumferential pressure and associated vasospasm.

In these and similar cases of acute renal failure the writer feels that the decision to decapsulate depends on the response to paralysis of the sympathetic. If there is no return of function within a few hours of such paralysis then the operation should be undertaken without delay.

The role of peritoneal dialysis is discussed.

Failure to relieve suppression by decapsulation will occur in the following circumstances : (*a*) Where cortical necrosis is already far advanced ; (*b*) Where stripping is prevented by previous disease ; (*c*) Where there is persistent and unsuspected fœtal lobulation of the kidneys.

I wish to thank Mr. K. C. Jaidka and Dr. G. F. Walker for asking me to treat these cases ; Dr. R. Williamson, of the Department of Pathology, Cambridge University, for the microphotographs ; Dr. D. H. Fulton for the pathological reports ; and Mr. A. Bowring for the cystoscopic paintings.

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THE LOOSER-MILKMAN SYNDROME

OCCURRENCE IN A CASE OF IDIOPATHIC STEATORRHŒA

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SINCE Milkman (1930, 1934) published his report of a case with multiple spontaneous idiopathic symmetrical pseudo-fractures, several cases with similar features have been described. Although aware that Looser (1920) had described comparable bony lesions in cases of hunger osteopathy, the absence of dietetic deficiency and the failure to respond to vitamin D in his case led Milkman to believe he was dealing with a separate disease entity, a view which has been supported by several subsequent writers. The multiple pseudo-fractures which were the cardinal feature of Milkman's case have since been found in a wide variety of skeletal disorders. Camp and McCullough (1941) have given a list of conditions in which these lesions may be found, though many of them are in fact examples of rickets or osteomalacia. Albright, Burnett, Parson, Reifenstein, and Roos (1946), however, point out that although pseudo-fractures in conditions other than osteomalacia may resemble the translucent zones of Milkman's syndrome, the symmetrical ribbon-like zones of decalcification which occur in otherwise normal appearing bone and which last a long time without regressing are found only in osteomalacia. The view that Milkman's syndrome is a form of osteomalacia is supported by the observations of Edeiken and Schneeberg (1943), Herold (1944), and McCance (1947). The different aetiologies of osteomalacia, some of which have only recently been elucidated, have been responsible for confusion, but it is now realized that Milkman's syndrome may be a manifestation of this disease however it arises. A brief account of the salient features of this syndrome follows. The main findings in other reported cases are summarized in *Table I*.

RADIOLOGICAL APPEARANCES

The essential lesions which distinguish this syndrome are band-like zones of decalcification occurring in normal-looking bone. These lesions have been called pseudo-fractures, as a breach in the continuity of bone may be apparently complete without evident displacement of the bone ends. Radiologically they show as clear-cut translucent bands extending transversely or diagonally across the long axis of the affected bones. There may be some bony condensation at the surfaces adjacent to the translucent area and some periosteal proliferation over the defects, but more frequently there is no reaction to indicate a healing process. The lesions tend to be symmetrical, and although this was a prominent feature in Milkman's case it is not constant in all other cases. Trauma may convert the decalcified zone into a true fracture with displacement, but this is not commonly seen until the condition is advanced.

The occurrence of spontaneous fractures without displacement in proved cases of osteomalacia was originally demonstrated by Looser, who called the lesions '*umbauzonen*', or zones of transformation, to indicate a change from bone to callus. He believed that the process was due to small infractions of bony trabeculæ which by summation in the weakened area eventually produced a break in continuity. On the other hand, Kind (1947), who found osteonecrotic changes in the bones of a case at autopsy, considered the lesions were more akin to aseptic necrosis of bone tissue than to true fractures. In the initial stages a defect appears in the cortex of the bone and gradually extends around the shaft. Any bone in the skeleton may be involved, and in several cases the lesions are numerous (in Milkman's case 43 skeletal defects were found at autopsy). The pseudo-fractures do not necessarily become complete, for the periosteum over the defects may remain intact and bony trabeculæ may persist between the ends of the decalcified bands.

The surrounding bone may be normal or changes varying from a slight general decalcification to frank osteomalacia may be seen. The site of the pseudo-fractures is probably determined by the pull of the muscles and ligaments attached to the bone. Gross trauma is not responsible and the symmetrical distribution of the lesions points to stress and strain as the responsible agents for the site of the lesions. The most characteristic sites of these pseudo-fractures are in the superior and inferior rami of the os pubis and in the neck of the femur. The position of pseudo-fractures in 75 cases of Milkman's syndrome collected from the literature is as follows :—

Site of Pseudo-fracture	*Number of Cases*
Scapula	20
Clavicle	2
Sternum	2
Ribs	18
Humerus	4
Radius	9
Ulna	20
Metacarpals	4
Phalanges of hand	3
Vertebræ	7
Pelvis	50
Femur	35
Tibia	5
Fibula	11
Metatarsals	9
Phalanges of feet	1
Patella	1
Skull	2

SYMPTOMS AND SIGNS

The syndrome is much commoner in women, and only a few cases have been recorded in men. The symptoms may follow a pregnancy or a period of dietary insufficiency, and have usually been present for several years before the condition is recognized. The commonest complaint is pain in some part of the skeleton, most commonly the legs, which is aggravated by weight-bearing, motion, or fatigue. Backache is very frequent, and pains in the chest and abdomen may arise from rib fractures. The lesions of the femur and pelvis may cause a limp, and characteristic symptoms are difficulty in arising

from a sitting, supine, or kneeling position and inability to climb stairs. The classical example of this was Garcin, Legrand, and Bernard's (1937) case of a nun who had difficulty in arising from her knees after prayers. The patients may experience a feeling of insecurity or a sensation of 'giving way' of the affected part, so that a momentary hesitation occurs before starting to walk. Walking is slow and difficult and the sufferer may be weak and very unsteady on her feet. Some cases have a waddling gait resembling that seen in congenital dislocation of the hip or one of the myopathies. Any rapid or jerking movement is liable to cause a stab of pain in the affected part—"J'avais peur de me casser en faisant un mouvement". Pain may develop simultaneously in several parts of the skeleton, but more usually the onset is insidious and different parts are progressively involved. A striking feature in some of the recorded cases is the widespread character of the pain and skeletal tenderness, although radiological examination may reveal only two or three areas of pseudo-fracture. Exacerbation and remission of symptoms extending over a period of some years may occur; the remissions sometimes coincide with visits to the country (Debray, André, Thomann, and Gireaux, 1933) or with the onset of summer (Albright and others, 1946).

Physical examination may be quite negative. The general health is well preserved and there is usually no obvious malnutrition. Focal areas of tenderness on pressure elicited over the pseudo-fractures may be the only abnormal sign. There is no crepitus or abnormal mobility at the site of these lesions and deformity occurs only in advanced cases. Pain may be responsible for limitation of joint movement and muscular atrophy, several of the recorded cases having been mistakenly diagnosed as osteo-arthritis of the hips.

The biochemical findings are those associated with osteomalacia—namely, a normal or low serum-calcium, a low serum-phosphorus, and, in the cases in which it has been estimated, a raised serum alkaline phosphatase. Other abnormalities depend on the underlying pathological state. The case to be described shows many of the distinctive clinical features of this syndrome and has an unusual cause.

CASE REPORT

A woman, aged 46 years, was admitted to hospital on Sept. 25, 1946, complaining of shortness of breath on exertion, palpitations, and swelling of the ankles. These symptoms had commenced four months previously and had become gradually worse, with the addition of increasing pallor, weakness, and, during the last month, soreness of the tongue. For two years she had suffered from pain and stiffness in the right hip-joint which travelled down the front and medial side of the thigh. This pain came on especially when she rose from a sitting position and started to move, but after walking some distance it gradually wore off. During the last six months she complained of a similar pain in the left hip and an ache across the lower part of the back. At first the pains caused her to limp, but latterly, to use her own words, she could only "waddle about like a duck" and needed a stick for support. The pain now did not pass off after walking and was made worse by any movement of the legs. Lately she had noticed occasional aching pains in the upper parts of both arms. Her appetite was good, her bowels were regular, and there was no recent loss of weight. Her menses were regular, but scanty. She was a farmer's wife and her diet was good, containing adequate amounts of meat, bacon, butter, cheese, milk, and fresh vegetables.

ON EXAMINATION.—She showed extreme pallor of the skin and mucous membranes. The tongue was smooth and pale and the nails of the little fingers showed koilonychia. There was no apparent loss of weight and no enlargement of any lymph-nodes. Heart: not clinically enlarged; systolic murmur over apex and base; pulse collapsing in type, regular, good volume; B.P. 135/75. No abnormal signs in lungs, abdomen, or C.N.S. Pain was elicited on external and internal rotation of both thighs. There was slight limitation of abduction at the hip-joints, but no other abnormality was observed and no osseous tenderness could be elicited here or elsewhere in the skeleton. The patient's doctor sent her to hospital with a diagnosis of hypochromic anæmia and osteo-arthritis of the hip-joints.

Blood examination on admission showed:—

Red cells	1·81 m. per c.mm.
Hæmoglobin (Sahli)	28 per cent
Colour index	0·77
Reticulocytes	0·5 per cent
White cells	4000 per c.mm.

Blood-film: red cells showed hypochromasia, anisocytosis, and some poikilocytosis. The differential count showed:—

Polymorphs	60 per cent
Lymphocytes	21·5 " "
Eosinophils	9 " "
Monocytes	3·5 " "
Basophils	2 " "
Myelocytes	2·5 " "
Nucleated reds	1·5 " "

Marrow film showed normoblastic erythropoiesis.

Radiographs of hip-joints and pelvis showed a subtrochanteric pseudo-fracture of the right femur and a complete fracture in the neck of the left femur (*Figs.* 698, 700). The joint spaces appeared narrow and the bones showed some generalized decalcification. These changes suggested some dietetic or metabolic interference with calcium, so radiographs of the entire skeleton were proceeded with. These revealed, in addition to the lesions described, a horizontal area of rarefaction in the lower end of the left femur (*Fig.* 702) and band-like translucencies in the lower ribs of both sides, more clearly visible on the right (*Fig.* 704). Apart from a mild general decalcification, no other lesions were seen. The appearances of the translucent areas resembled Looser's zones, but full inquiry did not reveal any protein, fat, mineral, or vitamin deficiency in the patient's diet. A few days after admission she developed diarrhœa, which lasted a few days and did not recur. No history of previous attacks was obtained and there was no past history suggestive of cœliac disease or other intestinal abnormality.

The following investigations were carried out:—

Serum-calcium	9·7 mg. per 100 c.c.
Plasma-phosphorus	1·44 " " "
Serum alkaline phosphatase	13·8 units (Jenner and Kay).

Urine: Protein, a trace; no Bence-Jones protein. No sugar, acetone bodies, bile-salts, or bile-pigments. No excess of urobilin. Chlorides normal. Deposit contained numerous leucocytes and epithelial cells, but no red cells or casts.

Blood-Wassermann reaction negative.

Test-meal: histamine-fast achlorhydria. No blood or excess mucus in samples.

Urinary diastase	8 units
Blood uric acid	3·0 mg. per 100 c.c.
Blood-urea	20 " " " "
Serum-proteins	8·1 per cent (albumin 5·6 per cent; globulin 2·5 per cent by difference).

Fæces: Occult blood not present (six specimens); trypsin absent. Muscle-fibres, fat globules, fatty acid crystals, and soap plaques all present. Starch granules, red blood-cells, epithelial cells not seen.

Fæcal fat (Nov. 7) Total fat 47·8 per cent of dried fæces; 83·1 per cent split, 16·9 per cent unsplit.

Table I.—PRINCIPAL FEATURES OF SOME RECORDED CASES OF THE LOOSER-MILKMAN SYNDROME

AUTHOR	SEX	AGE	SITES OF PSEUDO-FRACTURES	CONDITION OF SKELETON	CA	P	PHOSPHATASE	TREATMENT	RESULT	SPECIAL FEATURES
Albright, Burnett, Parson, Reifenstein, and Roos (1946)	F.	37	Ribs, scapulæ, pelvis, femora	—	10·2	1·6	Incr.	Vit. D, starting with 900,000 units daily	Marked improvement	Symptoms followed pregnancy. Poor appetite
	F.	30	Metatarsals, ribs, pelvis, scapula	General decalcification	8·7	1·0	Incr.	Large amounts of fat-soluble vitamins; low fat diet; desoxycholic acid; liver extract	Prompt healing of fractures. Clinical improvement	Non-tropical sprue. Hypovitaminosis of fat-soluble vitamins
	F.	50	Femur (shaft)	General demineralization	9·7	3·4	Incr.	High calcium intake; iron; vit. D, 50,000 units daily; crude liver extract	Healing of fracture. Clinical improvement	Non-tropical sprue, anæmia. Symptoms improved in summer
	F.	40	Scapula, radius, ulna, phalanges of hand, rib, pelvis	General decalcification	9·5	1·9	Incr.	Vit. D, 30,000 units daily; calcium gluconate, sodium citrate	Dramatic improvement. Healing of fractures	Renal acidosis (albuminuria, low CO_2-combining power of serum, high serum-chloride)
	F.	18	Ribs, pelvis, humeri	General demineralization; decreased stature; scoliosis; coxa vara	10·4	1·9	Incr.	Vit. D, Sodium citrate, Calcium — large amounts	Clinical improvement	Renal acidosis; nephrocalcinosis
	F.	23	Rib, scapula	—	9·7	2·8	Incr.	—	Death	Renal acidosis; chronic pyelonephritis; nephrolithiasis
Belger (1942)	F.	62	Ulnæ, ? Tibiæ (complained of pain, but no radiographs)	Generalized decalcification	—	—	—	Calcium; vitamins; U.V.L.	No success	Morphine addict; dyspepsia; anorexia; dietary insufficiency
Bénard, Rambert, Deparis, and Horn (1944)	F.	57	Ulnæ, pelvis, fibula, femur	Generalized decalcification	10·4	1·9	N.	Calcium gluconate; vit. D_2; U.V.L.	Clinical and radiological improvement	Severe dietary restriction
Boudènes (1945)	F.	61	Femora, radii, ulnæ	Osteoporosis of vertebræ; dorsal kyphosis	7·75	—	—	Vit. D; Ca gluconate injections; U.V.L.	Clinical cure. Slight radiological improvement	
	F.	58	Pelvis, femur	Osteomalacic deformity of pelvis. Dorsal kyphosis	—	—	—	Sterogyl; calcium intravenously; U.V.L.	Great clinical, considerable radiological improvement	
Brick and Bunch (1947)	M.	37	Vertebræ, ribs, sternum, clavicles, scapulæ, radii, phalanx of finger, pelvis, femur, patellæ	Moderate generalized osteoporosis. Coxa vara	8·8–11·6	1·6–3·8	Incr.	Large doses vit. D	Gain in weight. No change in bone condition	Intermittent glycosuria
dall'Acqua, Levi, and Bordoli (1936)	F.	43	Pelvis, tibiæ, metatarsus, scapula, ulnæ, radii, ribs	Heart-shaped pelvis. No osteoporosis	8·9	3·3	Incr.	Vit. D and calcium	Not successful	Slight albuminuria
Debray, André, Thomann, and Gireaux (1933)	F.	51	Ribs, scapulæ, pelvis, femora, phalanges of toes, metacarpal	Severe general decalcification, funnel chest, scoliosis, coxa vara	11·4	2·4	—	Arsenicals. Médicament phosphoré	Recalcification and healing of fractures	Symptoms began after pregnancy. Improvement during stay in country
Debray, Alison, and Husset (1943)	F.	43	Pelvis, ribs, scapula	—	—	—	—	Sterogyl; calcium gluconate; injections parathyroid	Clinical cure	Diet may have been insufficient
Dereux (1943)	F.	35	Femur (lesser trochanter)	—	—	—	—	Vit. D	Clinical and radiological cure	
De Sèze (1944)	F.	62	Pelvis (os pubis)	Triangular and decalcified pelvis	—	—	—	Calcium and phosphorus by mouth; Ca gluconate I.V.; Sterogyl	Rapid clinical and radiological cure	Severe malnutrition. Living strictly on rations
	F.	60	Pelvis (pubic rami)	General decalcification; kyphoscoliosis	—	—	—	Calcium and phosphorus by mouth. Ca gluconate I.V.; Sterogyl; sunbaths	Complete clinical and radiological cure	Severe malnutrition (strict rations made worse by diet imposed for hypertension). Lack of light

Table I.—PRINCIPAL FEATURES OF SOME RECORDED CASES OF THE LOOSER-MILKMAN SYNDROME, *continued*

AUTHOR	SEX	AGE	SITES OF PSEUDO-FRACTURES	CONDITION OF SKELETON	CA	P	PHOSPHATASE	TREATMENT	RESULT	SPECIAL FEATURES
De Sèze (1944)	F.	66	Pelvis (os pubis)	Localized decalcification of femoral heads	8·4	—	—	Calcium; vit. D	Complete clinical and radiological cure	Severe malnutrition (unsupplemented rations and diet for hypertension)
Edeiken and Schneeberg (1943)	F.	34	Clavicles, scapulæ, radius, ulnæ, ribs, femora, tibia, metatarsals	General decalcification, heart-shaped pelvis	9·6	2	N.	50,000 units vit. D; Ca lactate; U.V.L. to torso	Free of pain though still waddling. Excellent radiological healing	
Françon, Robert, and Monnier (1944)	F.	45	Pelvis (pubic rami)	Diffuse decalcification, heart-shaped pelvis, deformed thorax, kyphoscoliosis, osteoarthritis of hips	—	—	—	Injections Ca gluconate and product containing vits. A and D	Notable clinical improvement. Healing of pseudo-fractures but no improvement in pelvic deformity	Recent pregnancy
Forestier (1944)	F.	53	Pelvis (pubic rami)	General decalcification	8·1	2·3	Incr.	Intravenous calcium; vit. D	Considerable improvement	Past history typhoid complicated by nephritis and cardiovascular disease. Alimentary restrictions
	F.	51	Pelvis (pubic rami)	Diffuse decalcification	—	—	—	—	—	Well nourished
	F.	59	Ulnæ	Kyphosis	7·8	—	—	"Recalcifying treatment"	Good repair of pseudo-fractures	Severe malnutrition. Living strictly on rations
Garcin, Legrand, and Bernard (1937)	F.	58	Pelvis (pubic rami)	—	10·4	—	N.	Calcium; vit. D by mouth. Injection vit. A	Clinical and radiological cure	Reduced diet owing to hypertension
Guillain, Lerebouillet, and Auzépy (1937)	F.	55	Pelvis, ribs, scapulæ	General decalcification of pelvis	11·3	4·8	N.	Vit. D	Clinical and radiological cure	Gastro-intestinal troubles. Dieted herself strictly. B.M.R. + 41
Herold (1944)	F.	34	Pelvis, scapulæ, femur, fibula, ribs	—	9·2	4·4	Incr.	Vit. D (total 3 million I.U.); calcium	Rapid cure	Poor fat absorption due to chronic dyspepsia. Insufficient light. Rickets as child
	F.	40	Pelvis, scapulæ, femur	Slight general decalcification	9·2	3·4	Incr.	Vit. D (600,000 I.U.)	Permanent cure	Enteritis and small growth. Essential anæmia
	F.	65	Pelvis, scapula	Severe general decalcification	8·5	2·4	Incr.	Vit. D (735,000 I.U.)	Permanent cure	Senile osteomalacia. Avitaminosis D
	F.	53	Pelvis, femur, scapulæ, ulnæ, metatarsals	Severe general decalcification	9·3	2·4	Incr.	Vit. D. Blood transfusion	Cure	Sprue, hypochromic anæmia. Plummer-Vinson syndrome
	F.	47	Pelvis, ulna, femur	Severe general decalcification	8·4	—	—	Intensive vit. D	Cure	Symptomatic P.A.-like anæmia. Sprue-osteomalacia
	F.	50	Pelvis, sternum	High-grade osteoporosis	8·3	2·3	N.	Vit. D; calcium; U.V.L.	No improvement	Presenile osteoporosis. P.A.-like anæmia (Hb 18 per cent). Chronic enteric dysfunction. Senile dementia
Justin-Besançon, Cachera, Rubens-Duval, and Delbarre (1945)	F.	52	Fibulæ, ulna, femora	—	9·8	2·2	N.	Calcium; phosphorus; vit. D_2	Spectacular cure	Severe dietary restriction owing to poverty. Lack of light. Anæmia.
	F.	61	Necks of femora	Diffuse decalcification	12	2·3	N.	—	—	Dietary insufficiency
	F.	53	Fibulæ, femora, ulna	—	9·7	2·2	N.	—	—	Severe malnutrition. Lack of light. Ate a lot of bread
Kind (1947)	F.	79	Pelvis, ribs, ulnæ, femur	Diffuse generalized osteoporosis. Heart-shaped pelvis	N.	N.	Incr.	Vit. D; calcium phosphate	Disappearance of skeletal pains but only slow radiological improvement. Later, death from cardiac failure	Hypochromic anæmia

Langeron and Béra (1945)	F.	19	Scapulæ, ulna, femur, fibula	General decalcification. Heart-shaped pelvis. Scoliosis	8	7·6	Incr.	Vit. D ; calcium	Complete clinical cure	Restricted diet owing to digestive troubles. Rickets
	F.	79	Pelvis (pubic rami)	General decalcification	9	—	Incr.	Vit. D ; calcium	Complete clinical cure	Poor diet
Langmead (1935)	M.	23	Pelvis (pubic rami)	General decalcification	9·4	1·99	—	Radiostoleum ; iron ; intravenous calcium gluconate	Clinical improvement. Radiological healing of fractures	Steatorrhœa. Iron-deficiency anæmia
Leedham-Green and Golding (1937)	F.	24	Pelvis, metatarsals, skull	General decalcification	9·6	2·2	Incr.	Radiostoleum. Calcium lactate	Not stated.	
Lepennetier, Gilbrin, Godefroy, and Tricot (1945)	F.	73	Radius, ulnæ, pelvis, fibula, ribs, vertebræ	Discrete osteoporosis	—	—	—	Sterogyl. Calcium gluconate and phosphate	Rapid recovery. Complete healing on radiographs	Poverty. Living in dark room
Leriche and Jung (1938)	F.	38	Femora, pelvis	—	8	—	—	Vit. D ; calcium ; U.V.L.	Improved	
McCance (1947)	F.	23	Ulna, pelvis, femur, tibia, humerus	Extensive decalcification. Lump in shaft of femur. Coxa vara, kyphosis and lordosis	10·3	2·1	Incr.	Vit. D, 500,000 I.U. daily (total 21 million units)	Symptomatic cure. Radiological recalcification and callus formation → normal appearances	Raised resistance to vit. D
Michaelis (1932)	M.	18	Pelvis, scapulæ, radii, tibiæ, femora, metatarsals, humerus, metacarpus, skull	General decalcification. Coxa vara. Vertebral compression	11·6	1·6	—	Phosphorized cod-liver oil ; 'vigantol' ; 'paratotal'	No response to treatment	
Milkman (1930 ; 1934)	F.	43	Femora, ribs, ulnæ, scapulæ, metatarsus, radii, fibulæ	General decalcification	10	2	—	Phosphorized cod-liver oil ; heliotherapy ; calcium lactate ; viosterol ; parathyroid extract	No response to treatment. Progression of fractures to death	Intermittent glycosuria. Diffuse nephritis. History of renal calculi
Monier-Vinard (1940)	F.	36	Metacarpals, phalanges of fingers, ulna, femur, fibulæ, metatarsals, phalanx of toe	General decalcification. Kyphoscoliosis. Osteomalacic deformities of pelvis, femoral heads, sternum	7·5	—	—	Vit. D ; calcium gluconate ; milk ; U.V.L. ; injections of parathyroid	Clinical improvement	Frank osteomalacia and chronic tetany
Nicaud, Lafitte, Gros, and Gautier (1942)	M.	41	Femora, scapula	—	10·4	—	Incr.	Calcium ; vit. D ; parathyroid extract	Cure	Chronic cadmium intoxication
	M.	60	Scapula, femur	Lumbar scoliosis	10·3	6	—	Calcium ; vit. D	Cure	
	F.	48	Fibula	Left tibia like Paget's disease	—	—	—	—	—	
	F.	51	Fibulæ, pelvis	—	—	—	—	—	—	
	F.	60	Femur	—	—	—	—	Calcium ; vit. D	Great improvement	
	F.	37	Scapula, pelvis	Decalcification of spine and femoral heads	9·4	1·2	Incr.	—	—	
Ponthus and Rocher (1945)	F.	51	Femora, ribs, metacarpal	—	—	—	—	—	—	
Ravault, Girard, and Didierlament (1938)	F.	61	Femora, radius, ulna	Generalized osteoporosis	7·75	8·7	—	Vit. D ; calcium gluconate ; U.V.L. to body	Clinical improvement. No radiological change	Albuminuria. Previous renal lesion : nephrectomy
Roger and Huguet (1938)	F.	62	Pelvis (pubic rami)	Slight general decalcification	—	—	—	Calcium ; phosphates ; vit. D ; liver extract ; D.X.T.	Slow improvement. Radiological union	
Wettstein (1947)	F.	44	Ribs, pelvis	Heart-shaped pelvis	—	—	—	—	Diagnosed at autopsy	Psychiatric patient. Histology of florid osteomalacia
	F.	74	Pelvis, femur, ulna	General osteoporosis. Osteomalacic deformity of pelvis. Kyphoscoliosis. Tumours of ulna	9·5	2·2	Incr.	—	Death	Rickets in infancy. Digestive troubles. Anæmia
	F.	86	Ribs, vertebræ	General demineralization. Severe scoliosis	9·1	2·4	—	—	Death	

FIG. 698.—Radiograph of upper end of right femur, showing linear pseudo-fracture of shaft.

FIG. 699.—Radiograph of right femur six months after commencement of treatment, showing complete healing of pseudo-fracture.

FIG. 700.—Radiograph of left femur, showing fracture of neck.

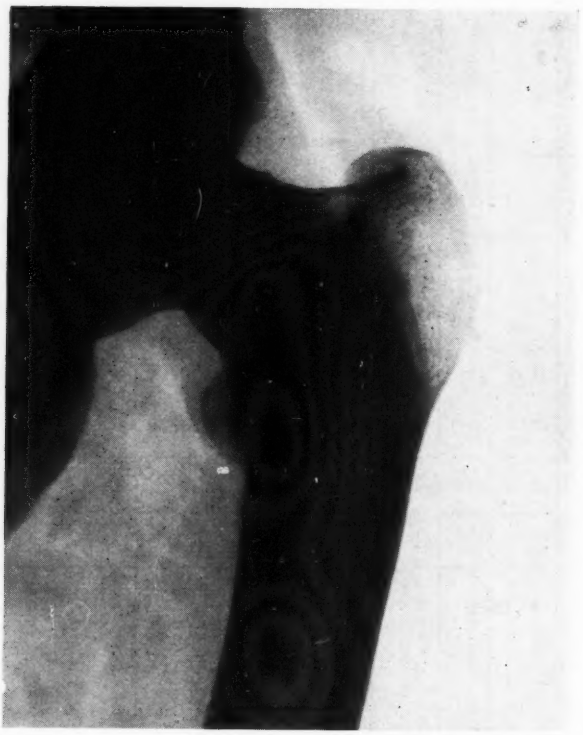

FIG. 701.—Radiograph of left femur six months after commencement of treatment, showing healing of fracture.

Sugar-tolerance curve :—

	Blood-sugar	
Before dextrose	0·110 per cent	
½ hour after dextrose	0·120 „ „	No urinary sugar
1 „ „ „	0·151 „ „	
1½ „ „ „	0·143 „ „	
2 „ „ „	0·127 „ „	

A biopsy of the eleventh right rib was performed, the portion removed including the angle and the area of translucency seen in the radiographs (*Fig.* 706). The following report on its pathology was given by Dr. J. G. Thomson : " The specimen is a portion of rib 9·5 cm. long showing 4 cm. from the anterior end a fusiform swelling 1·2 cm. long which thickens the rib to 0·8 cm. The swelling is firm and white in colour and most of it is evident anteriorly, though there is a slight posterior projection. Section shows at the point of swelling a partial replacement of red marrow by firm bone. The outlines of the cortex are still recognized on the pleural side especially, and most of the swelling appears to be due to subperiosteal bone.

" *Histology* : On either side of the swelling the bone presents no obvious abnormality. At the point of maximum swelling the periosteum on the pleural surface is greatly thickened, but appears poor in cells and inactive. Directly opposite this on the external surface there is a layer of osteoid tissue under the periosteum, recent and active and with abundant osteoblasts. Throughout the swelling the bone-marrow has disappeared and is replaced by bone largely deficient in calcification and by small nodules of cartilage. Signs of bony activity with osteoblasts are evident, but hardly to the degree seen in the subperiosteal bone. With the polarizer it is seen that the formation of bone round the Haversian canals in the swelling is defective and most of the collagenous fibres are not doubly refracting. Signs of old hæmorrhage in hæmosiderin deposits as in a fracture are not present, yet these appearances are more in keeping with those of a fracture with deficient repair and ossification than of anything else."

FIG. 702.—Radiograph of lower end of left femur, showing pseudo-fracture.

TREATMENT with large doses of vitamin D, calcium, and iron was commenced. The patient received Ostelin high-potency vitamin-D tablets (Glaxo) 100,000 units daily, calcium lactate 15 gr. t.d.s., and ferri et ammon. cit. 30 gr. t.d.s. This treatment was continued for three months. The anæmia showed a rapid response to the iron medication and after six weeks' treatment the blood-count was :—

Red cells	3·83 m. per c.mm.
Hæmoglobin	70 per cent
Colour index	0·91

FIG. 703.—Radiograph of lower end of left femur six months after commencement of treatment.

The patient was then discharged from hospital and treatment was continued at home by Dr. Clayburn, of Allendale. He kept a close watch for toxic symptoms to calciferol and tested her urine at weekly intervals. She remained in bed for three months and then began to get up very gradually, sitting in a chair for a further month before she began to walk. During this time she was eating a full diet and drinking at least 2 pints of milk a day in addition to the prescribed therapy. Her appetite was excellent, her bowels regular, and she gained almost a stone in weight. From the time she got home she never experienced any pain in the hips, and although she felt weak when she started to walk, movement and weight-bearing were not painful. She returned to hospital in May, 1947, for review. At this time she was doing light housework and cooking and felt strong and well.

ON EXAMINATION (May 14, 1947) : She looked healthy and rubicund. The tongue was smooth at the edges, but not pale, and the koilonychia had disappeared. No abnormal signs were detected and her gait was quite normal. The blood-count was now :—

Red cells	4·89 m. per c.mm.
Hæmoglobin	93 per cent
Colour index	0·95
White cells	13,900 per c.mm.

Other investigations now showed :—

Serum-calcium	10·4 mg. per 100 c.c.
Plasma-phosphorus	3 „ „ „ „
Serum-alkaline phosphatase	6·9 units (Jenner and Kay)
Blood-urea	32 mg. per 100 c.c.
Serum-protein	6·2 per cent (albumin 4·8 per cent ; globulin 1·4 per cent by difference)
Fæcal fat	44 per cent of dried fæces (73·9 per cent split, 26·1 per cent unsplit)

Radiographs of the skeleton showed calcification of all the translucent zones. The bone texture now appeared normal and the fractures of the femora had united (*Figs.* 699, 701, 703, 705).

The patient has been under regular observation for 2½ years since then. No further vitamin D or calcium lactate has been administered, but she has continued to take iron and drink 2 pints of milk daily. She has remained in excellent health and has never suffered from pains or a recurrence of the anæmia. One year after her first admission to hospital she was able to walk 8 miles over rough country and perform all her usual household tasks. Radiographs taken at intervals have not shown any fresh lesions and the bones have remained well calcified.

FIG. 704.—Radiograph of right lower ribs, showing pseudo-fractures in 9th, 10th, and 11th ribs.

FIG. 705.—Radiograph of ribs six months later, showing healing of pseudo-fractures.

DISCUSSION

This patient when first seen was severely crippled and almost bedridden from the femoral fractures and general osteoporosis. After three months' treatment with large doses of vitamin D and calcium she showed a dramatic clinical improvement and within six months was able to resume a normal life. The symptomatic relief was accompanied by radiological evidence of healing of the fractures and recalcification of the bones. There was also a marked degree of hypochromic anæmia, the symptoms of which had actually been responsible for her admission to hospital. This responded well to iron therapy. The steatorrhœa was discovered during a routine search for factors likely to cause a disturbance of calcium metabolism. The patient did not complain of any alimentary disturbance and although some specimens of fæces were pale and bulky, many had a normal appearance. No specific dietary treatment was given and the patient has remained well for three years without any further symptoms of this disorder.

Almost all cases of Milkman's syndrome have been shown to be due to deficiency of vitamin D, and the syndrome must be considered as a variant of osteomalacia, as it was originally described by Looser. The deficiency may be due to inadequate dietary intake, deficient absorption, or defective utilization of the vitamin. Osteomalacia arising from simple dietetic deficiency is rare in temperate climates. Looser's cases occurred at a time of famine after the first World War and more recently De Sèze, Ordonneau, and Godlewski (1946) have reported 20 cases occurring in France after the liberation which were characterized by pains, loss of power, and skeletal fractures of the Looser-Milkman type. The majority of these cases were living strictly on their rations, unsupplemented by black-market food, and, like the cases of Looser, they responded promptly to treatment with calcium and vitamin D. In more normal times, the aetiology is more complex, and a survey of the recorded cases of Milkman's syndrome shows that in many cases multiple factors were probably responsible. The diet may have been restricted because of gastro-intestinal ailments, morphine addiction (Belger, 1942), or hypertension (Garcin and others, 1937), while lack of sunlight may play a part in causing the so-called Cloister osteomalacia (Herold, 1944). In several cases (Debray and others, 1933 ; Albright and others, 1946) the symptoms have commenced after a pregnancy.

McCance (1947) reported a case of Milkman's syndrome in a girl who acquired a raised resistance to vitamin D at about the age of 15 years. She was

found to be in negative calcium and phosphorus balance, but ordinary dosage of vitamin D (7500 units daily at one stage) failed to produce much improvement. 500,000 units of vitamin D daily were then prescribed, and after a total dosage of 21 million units, radiographs showed recalcification of the skeleton and callus formation at the site of the pseudo-fractures. A similar raised resistance to vitamin D (R.R.D.) may have been present in several of the recorded cases which failed to respond to treatment. In some of these the dosage is not stated,

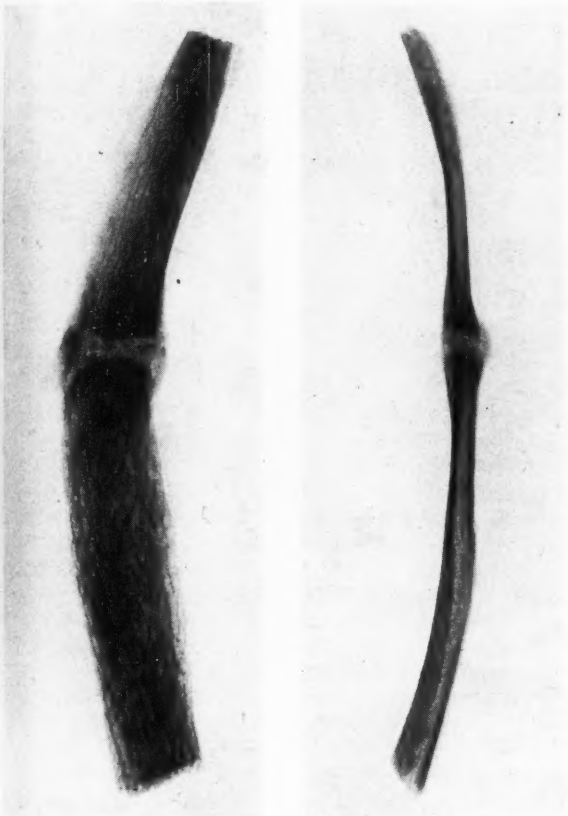

FIG. 706.—Radiographs of section of rib removed for examination.

but most probably the vitamin was given in normal therapeutic quantities. Albright and others (1946) have recently uncovered another condition—renal acidosis—which may produce osteomalacia with Milkman's syndrome. A high serum-chloride and low serum CO_2 content were the characteristic findings, and in some of their cases albuminuria, pyuria, and renal calculi were present. It also appears that chronic cadmium intoxication may lead to similar skeletal changes (Nicaud, Lafitte, Gros, and Gautier, 1942).

In the case recorded above the relationship of the Looser-Milkman syndrome to its underlying cause, idiopathic steatorrhœa, is apparent. It is interesting to observe how this malady caused symptoms by its secondary manifestations—namely, the anæmia and the skeletal changes arising out of malabsorption of vitamin D. Other cases of Milkman's syndrome in association with idiopathic steatorrhœa or sprue have been described by Langmead (1935), Herold (1944), and Albright and others (1946). Hypovitaminosis D is relatively common with steatorrhœa, but this peculiar form of osteomalacia is rarely seen.

SUMMARY

The clinical manifestations and radiological appearances in Milkman's syndrome are described and the various aetiological factors responsible for its development discussed.

A case is reported in a woman aged 46 who had a complete fracture of the neck of the left femur and pseudo-fractures in the ribs, in the subtrochanteric region of the right femur, and in the lower end of the left femur.

In a search for the underlying cause the patient was found to have idiopathic steatorrhœa. This was not causing any alimentary disturbance but there was a profound hypochromic anæmia associated with histamine-fast achlorhydria.

The patient was treated with vitamin D (100,000 units daily) calcium and iron for three months, which resulted in a dramatic clinical cure with complete healing of the fractures. She has since been observed for three years without developing any further symptoms.

I am indebted to Dr. A. G. Ogilvie for his helpful suggestions and for permission to publish the case; to Dr. J. G. Thomson for the pathological report; and to Dr. Whately Davidson for permission to reproduce the radiographs.

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PORTAL EMBOLISM FOLLOWING THROMBOSIS OF SPLENIC VEIN, AND CAUSING INFARCT-LIKE CYANOTIC ATROPHY ('ZAHN'S INFARCTS') OF THE LIVER

A COMPLICATION OF SPLENECTOMY PERFORMED IN THE COURSE OF TOTAL GASTRECTOMY

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IN the belief that any observations are of value which may throw light on causes of post-operative deaths, it is the object of this note to report the occurrence of so-called 'Zahn's infarcts' of the liver as a complication of total gastrectomy in the course of which splenectomy was performed.

This complication does not seem to be widely known, and, as it appears reasonable to believe that it contributed to the fatal outcome in a number of cases recently observed in the post-mortem room, a short account of the condition may be of interest to surgeons and pathologists, and encourage recognition of further cases. In this way, it may be possible for the frequency and importance of the complication to be studied, particularly with reference to the efficacy of measures designed to prevent it.

PATHOLOGY

The condition which Zahn (1897) called 'atrophic red infarct of the liver' is uncommon, but less rare than is often thought. It is due to the effects on the intrahepatic circulation of sudden occlusion of a branch of a portal vein, when this is associated with inadequacy of the normal interlobular anastomotic circulation or with retarded drainage of blood from the liver into the vena cava. The lesions resulting from these combined portal and systemic circulatory disturbances are generally known as atrophic red infarcts, or *Zahn's infarcts*, although Zahn was not the first to observe them. Earlier accounts of lesions of this type are those by Köhler (1893) and Newton Pitt (1895). Wooldridge (1887) had previously described the experimental production in the liver of what he called 'hæmorrhagic infarcts', and the lesions which he describes appear to have been identical with those later recorded by Zahn. As the lesions which are known by Zahn's name are not true infarcts, Gerlach (1930) suggested 'infarct-like red or cyanotic atrophy' as a more appropriate designation.

The lesions, which may be single or multiple, vary in size from 1–2 cm. in diameter up to involvement of the greater part of a lobe, and they correspond in extent with the amount of liver supplied by the occluded branch of the portal vein. They are deep red or purple, and firm in consistency. They have an irregular outline, and are sharply delimited from the pale, uninvolved neighbouring tissue. Their shape is roughly pyramidal, the apex at the site of venous occlusion and the base at the surface of the liver. When cut across, their surface is usually seen to be slightly sunken below that of the rest of the liver; sometimes there is no difference in level, or the differences are reversed. To some extent the level depends upon the amount of engorgement relative to the degree of atrophy in the lesions, and upon the amount of swelling of the surrounding liver tissue due to degenerative changes (cloudy swelling, fatty change).

Thus, macroscopically, the lesions resemble infarcts. They are, however, not true infarcts, but localized areas of circulatory stasis, combined with atrophy and degeneration of the parenchymal cells, but with little or no necrosis.

Histologically, the centrilobular venules and the sinusoids in the affected areas of the liver are dilated, and engorged with blood. The liver cells are reduced in size. Their cytoplasm is compact, granular, and more eosinophil than usual. Hyaline globules may be present in it, and lipochrome is often considerably more abundant than in the uninvolved parts, particularly in cells around the centre of affected lobules. The nuclei are often shrunken, staining intensely with hæmatoxylin; hydropic change and karyolysis are common. The cytological changes are severest in the central zone of the lobules, where many cells may disappear, and the remaining ones show advanced atrophy and degenerative changes up to necrosis. The cells nearest to the portal tracts show slight or no alteration. There is usually no abnormality in the portal

tracts, except dilatation and engorgement of the veins.

The microscopical appearances are similar to those seen in mild grades of chronic venous congestion and in terminal passive congestion of the liver; they are confined to the areas which to the naked eye resemble infarcts.

Sometimes, although the macroscopical appearances are striking and unmistakable, it is difficult at first to detect the corresponding changes microscopically, especially when sections are examined at the usual 'low-power' magnification of 50 to 90 diameters. In these cases, however, the engorged area can usually be detected by the unaided eye or at eye-piece magnification, in hæmatoxylin-eosin preparations, because of the redder appearance given to affected areas by the eosin-stained erythrocytes packing the dilated sinusoids. As the veins and venules in the portal tracts of the affected parts are commonly much dilated and engorged, in contrast with those in the uninvolved areas, they also are a guide in selecting appropriate areas for microscopical study.

AETIOLOGY

The commonest immediate cause of an 'infarct of Zahn' is sudden occlusion of a branch of a portal vein by thrombosis or embolism. According to Anderson (1948), obstruction of intrahepatic branches of the hepatic artery, while often causing no recognizable change in the liver, may result in either a true infarct or a Zahn's infarct, and I have several times observed these results of arterial occlusion in cases of polyarteritis nodosa.

So far as is known, Zahn's infarcts do not develop if the only circulatory disturbance in the liver is occlusion of some part of the portal vascular tree: another factor must also operate—namely, a disturbance of the systemic circulation. The latter may be of two kinds: The first includes any condition, e.g., congestive cardiac failure, which results in a rise of pressure in the hepatic veins and their tributaries, so retarding drainage of blood from the liver, and encouraging backflow into the area supplied by the occluded branch of the portal vein. In the second a similar effect on the circulation in the liver may be produced by any condition, such as myocardial insufficiency or peripheral circulatory failure, which causes lowering of the arterial blood-pressure, and thus diminution of the blood-flow in the portal circulation and of the anastomotic arterial supply to the liver tissues.

The two systemic circulatory disturbances may operate alone or together. When neither is present, occlusion of a branch of the portal tree will not result in the local circulatory stasis and secondary hypoxic changes which characterize the lesions of Zahn's infarcts, as the blood-flow through the area supplied by the obstructed vessel will be maintained by the anastomotic circulation. When, however, either is present, a Zahn lesion is the usual result of the portal occlusion; occasionally, the total circulatory disturbance is sufficient to produce a true hæmorrhagic infarct.

Zahn's infarcts result from occlusion of medium-calibre branches of the portal veins, such as those arising from the main right and left divisions of the trunk. Stasis of blood in the viscera normally drained by the portal system does not develop, for sufficient of the portal tree remains patent to maintain the circulation through the liver.

The great reserve capacity of the liver makes it improbable that Zahn's infarcts, even when multiple and extensive, would cause any appreciable disturbance in its function, unless there were already a severe reduction in the reserve, due to serious degenerative changes in the parenchyma.

To some extent, the results of portal occlusion also depend upon the size of vessel involved. Sudden complete obstruction of the main portal vein causes very severe circulatory stasis in the viscera drained by the portal system, but, provided the general systemic circulation is maintained at an adequate level of efficiency, it is unlikely that infarction of the liver or infarct-like changes in it will occur. In such cases the liver may appear pale and show some fatty change; if the patient survives the effects of the portal obstruction on the other viscera, evidence of impaired liver function may be found for many months on biochemical investigation. The hepatic artery eventually can indirectly take over the functions of the portal vein, and subsidiary hepatopetal vessels from the alimentary viscera may also open up. Ultimately, in such cases, the liver shows a moderate degree of atrophy, or there may be no apparent macroscopical abnormality.

When, on the other hand, there is an associated disturbance of the general circulation, sudden occlusion of the portal trunk causes extensive damage to the liver, as well as severe effects on the circulation through the intestines, and early death results.

Occlusion of the main right or left branch of the portal trunk is followed by severe atrophy of the corresponding lobe of the liver and compensatory hypertrophy of the unaffected one. The changes in the involved lobe are essentially the same as those seen in the so-called infarcts of Zahn.

As already stated, Zahn's infarcts result from occlusion of portal branches of medium calibre. According to Gerlach (1930), occlusion of the smallest branches of the portal veins, those central to the interlobular anastomoses, produces true anæmic or hæmorrhagic infarcts. A limited experience of such cases does not confirm this generalization, as there may be no detectable evidence of circulatory disturbance in the areas supplied by even the smallest portal vessels.

ILLUSTRATIVE CASES

Cases recently observed, in which embolic occlusion of part of the portal tree complicated splenectomy, include the following:—

Case 1.—*Carcinoma of the stomach.* Male, aged 53 years. On March 19, 1949, total gastrectomy was performed, with splenectomy and partial pancreatectomy. The spleen and its vessels were healthy. His condition was satisfactory until the seventh day after operation, when signs of intestinal obstruction developed: on reopening the abdomen, jejunal ileus was found, but its cause was not apparent; he died 30 minutes after the laparotomy.

At Necropsy (performed 58 hours after death).—The abnormal findings were: Recent total gastrectomy, splenectomy, and partial pancreatectomy; antecolic

œsophagojejunostomy; low-grade post-operative fibrinous peritonitis; slight jejunal dilatation, with excess mucus secretion and moderate hyperæmia; collapse of base of each lung, with congestion and early bronchopneumonia; blood-stained post-operative effusion (450 ml.) in left pleural sac, with low-grade fibrinous pleurisy; fatty degeneration of myocardium; moderate dilatation of right cardiac ventricle; terminal passive congestion of viscera; mild atheromatosis; cloudy swelling of kidneys and adrenal glands; marked cloudy swelling and fatty change in liver (1750 g.), with multiple Zahn infarcts. There was no leakage or sepsis in the operation area, and no organic obstruction of the intestinal canal.

FIG. 707.—*Case* 2. Cut surface of liver, showing a large embolus (arrow) in a branch of the portal vein, and resulting Zahn infarcts (the dark areas). (× ½.)

The splenic vein measured 7·5 cm. from the point of ligation to its junction with the superior mesenteric vein. Thrombus was present in the 4·5-cm. stretch of the splenic vein between its ligated end and the point where the inferior mesenteric vein opened into it. The thrombus was commencing to organize, and its proximal part was fragmented. There was no ante-mortem thrombus in the mesenteric veins or their tributaries. Emboli, detached from the thrombus in the splenic vein, plugged several medium-sized branches of the portal vein, and corresponding with each there was a characteristic infarct-like lesion in the liver. The largest of these Zahn lesions involved approximately two-thirds of the anatomical left lobe, and those in the right lobe measured up to 8 cm. in greatest diameter. Their histological appearances were typical.

Case 2.—*Carcinoma of the stomach.* Male, aged 49 years. Total gastrectomy was performed on May 17, 1949, with incidental splenectomy and partial pancreatectomy. His condition was satisfactory until the sixth day after operation, when he suddenly developed signs of peritonitis. At laparotomy a leak in the duodenal stump was found and closed. He died a few hours later.

AT NECROPSY (performed 36 hours after death).—The anatomical diagnoses were: Recent total gastrectomy, splenectomy, and partial pancreatectomy, with Roux Y œsophagojejunostomy; subsequent closure of leak from infolded duodenal stump; generalized fibrinopurulent peritonitis; infected hæmatoma in retroperitoneal tissues in vicinity of bed of tail of pancreas, not communicating with peritoneal cavity; obstruction of splenic flexure by taut, œdematous mesentery of jejunum between œsophagojejunostomy and jejunojejunostomy; left hæmohydrothorax; bronchial obstruction by tenacious mucus; collapse of lower lobe of left lung, and partial collapse of left upper lobe and right lower lobe; terminal passive congestion of viscera; slight atheromatosis; cloudy swelling of kidneys and adrenal glands; cloudy swelling of liver (1500 g.), with multiple Zahn infarcts. The myocardium appeared healthy.

The mesenteric veins and their radicles were normal. The stump of the splenic vein was 6·5 cm. long and contained organizing thrombus in the 3·5-cm. stretch lateral to the union with it of the inferior mesenteric vein. Some of the thrombus had become detached, and had been carried as emboli to the liver, plugging several medium-calibre branches of the portal veins. The resulting Zahn lesions varied in size from 3 cm. to 8 cm. in greatest diameter (*Fig.* 707). They were histologically typical.

Case 3.—*Carcinoma of lower end of œsophagus, invading stomach.* Male, aged 62 years. Partial œsophagectomy, total gastrectomy, splenectomy, and partial pancreatectomy were performed on July 1, 1949. There was no abnormality of the spleen or its vessels. His condition was excellent for the following 48 hours, but then rapidly deteriorated, with development of dyspnœa, cyanosis, and a weak, irregular pulse. He rallied at first, but his condition then worsened steadily, and he died within 24 hours of the initial collapse, on the third day after operation.

AT NECROPSY (performed 28 hours after death).—The anatomical diagnoses were: Recent operation, as above, with Roux Y œsophagojejunostomy; partial collapse of left lung; pulmonary œdema and congestion; acute parenchymatous myocardial degeneration, with generalized dilatation of the chambers of the heart; passive congestion of all viscera; slight atheromatosis; cloudy swelling of kidneys and adrenal glands; severe cloudy swelling of liver (2300 g.), with marked fatty change.

The stump of the splenic vein measured 5·5 cm. in length, and was thrombosed, with resulting obstruction of several medium-sized portal veins by emboli (*Fig.* 708). The inferior mesenteric vein opened anomalously into the superior mesenteric vein, just below the union between the latter and the splenic vein. Both mesenteric veins and their radicles were free from thrombus. The embolic occlusion of the portal vessels had produced no morphological changes in the liver. Histologically, the liver showed only cloudy swelling and fatty change, with uniform, slight, vascular engorgement.

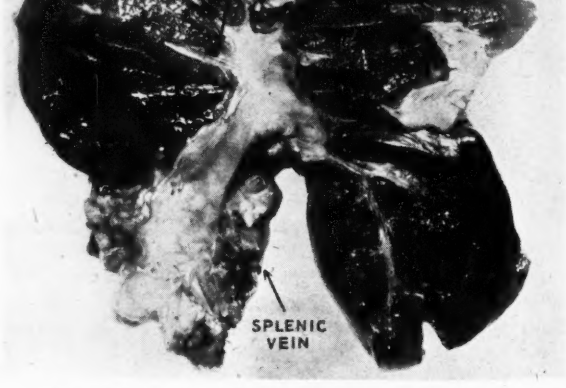

FIG. 708.—*Case* 3. Liver with portal tree opened *from in front*. The anomalous termination of the inferior mesenteric vein in the superior mesenteric vein can be seen a short distance below the junction between the latter and the splenic vein. Thrombus is present in the splenic vein, and emboli are seen in several branches of the portal vein. The dark area on the true right of the portal trunk is the gall-bladder. (× ¼.)

DISCUSSION

In all these cases splenectomy was followed, as would be expected, by thrombosis of the stump of the splenic vein. Portions of the thrombus became detached and were carried to the liver, where they lodged in medium-sized branches of the portal veins. There was no significant difference in their distribution between veins leading to left or right of Cantlie's plane*. In two cases, in which death occurred respectively on the sixth and seventh days after operation, typical Zahn infarcts resulted. These lesions showed characteristic histological appearances, with little apparent loss of parenchymal tissue. In the third case, the patient died on the third day after operation, following a sudden collapse, which clinically was considered to indicate peripheral circulatory failure. In this case, despite embolic occlusion of several portal branches, no infarct-like areas were present, possibly because the patient died too soon after occurrence of the embolism for morphological changes to have resulted.

In all three cases marked degenerative changes were present in the liver in addition to the infarcts, and also in the kidneys and adrenal glands; in two there were severe degenerative changes in the myocardium. In one case generalized fibrinopurulent peritonitis had developed, following leakage from the duodenal stump; in this case there was also early obstruction of the large intestine by the tightly stretched and swollen mesentery of the jejunum. Some degree of pulmonary collapse was found in all three cases, but it was of serious extent only in *Case* 2, the only case in which bronchial obstruction by mucus was demonstrable. In one case there was early bronchopneumonia.

Death in these cases appeared to be the result of a combination of factors, the consequences of the major surgical operation: Degenerative changes in the viscera, due to 'toxæmia' and circulatory inadequacy; infection; pulmonary collapse; and intestinal obstruction.

Obviously, it cannot be suggested that development of the so-called infarcts of Zahn is itself sufficient to account for death in these and similar cases. There seems, however, to be some justification in believing that, in association with severe degenerative changes in the rest of the liver, the occurrence of these lesions must still further diminish the functional reserve of that organ, with potentially serious consequences. Further, autolytic products will be released by the breakdown of cells at the centre of the lobules in the affected areas. Absorption of these would increase the demands on the detoxifying capacity of the rest of the already damaged liver, and their presence in the circulation would add to any existing toxæmia and augment its effects on the cardiovascular system, and on the function of the kidneys and other organs.

In each of the cases described above there was exposure to a variety of influences capable of damaging the tissues and interfering with their functions: Nutritional disturbances due to the alimentary disease for which operation was undertaken; sepsis associated with an ulcerated carcinoma; the necessity of prolonged anæsthesia, with its associated risks; the general lowering of functional efficiency due to impairment of cardiovascular and pulmonary activity, the result of the protracted surgical procedure and its complications, and of the conditions which prevail during the early phases of the post-operative period. These influences are potent factors in causing and aggravating degenerative changes in the viscera, and the liver is particularly susceptible to such damage.

The mortality of such major operations as total gastrectomy is considerable. It is obviously desirable to avoid, as far as possible, the development of complications which add to the risk of these procedures. The occurrence of Zahn's infarcts, by further damaging a liver already injuriously affected by other influences, such as those mentioned, may well be the critical event which, added to other factors, determines the final failure of the body's resistance to the effects of the operation.

Prevention of Embolic Lesions of the Liver complicating Splenectomy.—Ligation of the splenic vein is the first event in the sequence leading to development of Zahn's infarcts as a complication of splenectomy. Thrombosis is an inevitable result of ligation of any blood-vessel, provided the coagulability of the blood is normal. Proximal to the position of the ligature, thrombus fills the lumen as far as to the nearest point where free circulation can be maintained through an unobstructed branch or tributary. After splenectomy, therefore, thrombosis occurs in the column of stagnant blood which fills the splenic vein between the site of ligation and the point where it is joined by the inferior mesenteric vein. The blood-flow through the latter continues, and prevents thrombosis extending farther into the proximal part of the splenic vein, towards the portal vein. The farther the site of ligation of the splenic vein from the point where it receives its inferior mesenteric tributary, the greater will be the volume of thrombus formed, and therefore the greater the chance of extensive damage to the liver by embolic occlusion of branches of the portal vein. Moreover, the larger the thrombus in the splenic vein, the greater the risk which would accompany its complete detachment, for the resulting embolus could well be large enough to block the portal trunk itself, with rapidly fatal results due to the effects on the intestine of complete obstruction of the portal circulation, and to liver damage.

By providing a clear field in which to work, considerable advantage is gained by removing the spleen in the course of certain operations designed to accomplish radical excision of malignant disease of the stomach or œsophagus. More important, an integral part of any radical operation for cancer is the removal of as much as possible of the lymphatic drainage area of the organ primarily affected. In the case of the stomach and of the lower end of the œsophagus, this includes resection of the spleen with the lymph-nodes and lymphatics in its hilus, in the gastrosplenic omentum, and in the lienorenal ligament.

It is, therefore, obviously desirable to attempt to overcome any disadvantages of the splenectomy by

* Cantlie's plane, through the middle of the gall-bladder fossa and of the fossa of the vena cava, divides the liver into right and left halves, corresponding with the distribution of the right and left stream-lines of the blood-flow in the portal trunk.

modifying this step in the operation. The risks resulting from ligation of the splenic vein could be reduced to a minimum by tying it off as close to its junction with the inferior mesenteric vein as is practicable without causing damage to the latter. Although thrombus would inevitably form in the short stump of the vein, the results of detachment of part or even of the whole of it would be very much less than when a column of clot several centimetres long is present. In the small proportion of cases in which the inferior mesenteric vein does not join the splenic vein, but opens either into the superior mesenteric vein (*Fig.* 708) or in the angle formed by the junction of the latter with the splenic vein, ligation of the splenic vein should be performed as close to its termination as possible.

Theoretically, there are two ways by which the risk of thrombosis in the splenic vein could be almost completely obviated. Neither appears practicable. One, the use of anticoagulants, is clearly contra-indicated by the resulting liability to post-operative hæmorrhage. The other possibility is to make an anastomosis between the splenic vein and the left renal vein, but the resulting advantage of a safe splenectomy would be heavily outweighed by the extra time needed, by the addition to the complexity of the operation, and by the risk of interference with the circulatory and pressor mechanisms of the kidney.

Simple Splenectomy: Thrombosis of the Splenic Vein without Resulting Parenchymatous Lesions in the Liver.—As mentioned above, thrombosis always occurs in the stump of the splenic vein after splenectomy. Nevertheless, there does not seem to be the same liability to the occurrence of Zahn's infarcts after simple splenectomy as is the case when the operation is performed as an incidental step in the course of total gastrectomy. The possible reasons for this apparent difference require brief consideration.

There is no clear reason why thrombosis of the splenic vein should not as frequently be followed by portal embolism after simple splenectomy as it is after the more radical operations. There is no reliable evidence to suggest that venous thrombosis in general is more likely to result in embolism in old or debilitated people than in others. It is, in fact, quite possible that portal embolism does occur following simple splenectomy. If, in consequence of the embolism, the infarct-like Zahn lesions develop, their occurrence may well be undetected in patients who survive the operation, as these lesions are unlikely of themselves to cause either death or evidence of hepatic disorder. Should the patient die following the operation, the characteristic lesions may be missed at necropsy if the liver is only cursorily examined, or their appearances may be misinterpreted, and attributed to post-mortem 'gravitational' and pressure effects which may alter the distribution of the blood in the viscera. The emboli in the portal vessels are easily overlooked if the portal tree is not carefully opened up.

Zahn's infarcts and, more important, the associated disturbances of the general systemic circulation are more likely to be survived by younger patients. It is probably significant that the patients submitted to the radical operations, in which splenectomy is only an incident, are usually well past middle age, so that their general health has suffered progressive impairment, not only in consequence of disease of the alimentary tract, but also by the lowering of vitality associated with changes in the tissues due to advancing age. In these older patients, the strain on the diminished cardiovascular reserve, and the greater liability to develop severe post-operative shock, must inevitably predispose to the development of those disturbances of the general systemic circulation, combination of which with portal occlusion is essential for the development of Zahn's infarcts. The total surgical procedure in these cases is extensive and time-consuming, and its severity clearly much exceeds that of the majority of simple splenectomies. The latter are most frequently performed in younger patients, who are better able to withstand the effects of operation.

These factors may account for the apparent discrepancy between the effects of splenectomy on the circulation through the liver in the two groups.

SUMMARY

Attention is drawn to a circulatory disturbance in the liver occurring as a complication of splenectomy performed in the course of total gastrectomy.

The hepatic lesions ('infarct-like cyanotic atrophy', or so-called infarcts of Zahn) are the result of an orderly sequence: splenectomy—splenic vein thrombosis—portal vein embolism. Disturbance of the systemic circulation, such as occurs in shock, is an essential factor in the development of the infarct-like lesions in the areas supplied by the occluded branches of the portal veins.

The pathological appearances of the lesions in the liver are described. Three illustrative cases are briefly reported.

The possible importance of the condition is indicated.

Ligation of the splenic vein as close to its junction with the inferior mesenteric vein as possible is advisable as an invariable procedure in the course of total gastrectomy when combined with resection of the spleen. This has the object of limiting the amount of thrombus formed in the stump of the splenic vein, and thus of reducing to the minimum the number and size of any emboli which might be detached.

I am indebted to the surgeons concerned for permission to refer to the cases of patients under their care in the United Birmingham Hospitals.

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APPENDICEAL CALCULI

A REPORT OF TWO CASES AND A BRIEF REVIEW OF THE LITERATURE

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LITTLE attention has been drawn to the occurrence of radio-opaque concretions in the appendix by British authors. This may be due to the fact that they are rarely encountered, for several experienced surgeons have said that they have never seen a case. Two cases are reported here, one of which presented many interesting features in the quest for a correct pre-operative diagnosis. It must be admitted that the condition of appendiceal calculus was not considered. Wells (1930) has reported a case with similar features, particularly in respect of the unusual size of the calculus and the unexpected finding at operation that the calculus was within the appendix.

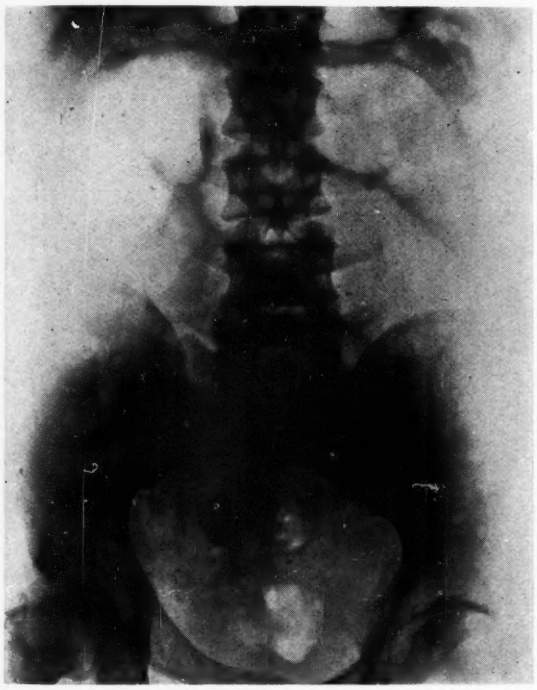

FIG. 709.—Straight radiograph of the abdomen in the supine position, showing the large calculus and marked small-bowel distension.

CASE REPORTS

Case 1.—J. T., aged 46 years, was admitted to hospital on July 29, 1948. He had been well until five days before, when he began to complain of central abdominal pain. At times this was colicky, but a constant ache persisted between the spasms. The bowels were constipated, but small amounts of flatus were passed. There was nausea and anorexia, but no vomiting. The pain settled into the right side of the abdomen, where he noticed persistent tenderness and he thought some swelling. There was no history of previous attacks of abdominal pain, indigestion, or flatulent dyspepsia. Apart from an accident as a boy, when he had a below-knee amputation of the left leg performed for sepsis following a compound fracture, he had suffered no other illness.

ON EXAMINATION.—He was an ill man with fœtid breath and furred tongue. Temperature 100·4° F.; pulse 100 per minute. The abdomen was diffusely distended, tender, and rigid, particularly in the central sub-umbilical area, where there was a palpable mass. This measured 3 in. by 3 in. and extended from just below the umbilicus in the midline to the right iliac fossa. On rectal examination there was marked tenderness anteriorly, but the mass could not be felt in the pelvis.

FIG. 710.—Lateral view of abdomen, showing the calculus on the posterior abdominal wall just below the brim of the pelvis. (Retouched.)

A provisional diagnosis of appendix abscess was made and routine conservative treatment commenced.

PROGRESS.—There was an early evidence of improvement in the patient's general condition and local signs. An irregular temperature persisted for nearly two weeks, but the local mass steadily decreased in size. In four days the bowels began to act normally without assistance and the abdominal distension rapidly disappeared. Even after five weeks the mass, although smaller, had not disappeared. He was apyrexial, but a white-cell count was still 12,000 per cm., with 85 per cent polymorphonuclear cells. He was discharged from hospital for follow-up as an out-patient, and further investigations were undertaken to exclude other causes for the abscess. A straight radiograph (*Fig.* 709) showed a large calcified mass with concentric laminations lying in the right iliac fossa, and a lateral view (*Fig.* 710) showed this to be situated on the posterior abdominal wall just below the brim of the pelvis. A barium enema (Dr. F. Pygott) was given and the report was that barium flowed normally to the cæcum. The lower pole of the cæcum was outlined clearly, and appeared to be indented by an extra-cæcal mass consistent with the previous inflammatory

lesion. Neither the terminal ileum nor the appendix could be filled (*Fig.* 711).

During the next two days the patient complained of further abdominal pain and was re-admitted. On examination there was central abdominal distension and visible peristalsis in the lower abdomen, and a succussion splash was detected. A tender mass could be felt in the right iliac fossa. In spite of the signs of intestinal obstruction the patient passed flatus and had had a normal bowel action each day since the onset of the second attack of pain. Within a few days it was evident that an abscess was coming to the surface and would need drainage. A local exploration was carried out and

FIG. 711.—Barium enema, showing normal filling of the large bowel with a regular indentation of the lower cæcal pole.

a large amount of pus was evacuated. The calcified mass could be felt in the posterior wall of the abscess, but exact localization was impossible.

Following drainage he rapidly lost his pain and nausea. His appetite returned and the temperature settled to normal. The wound discharged for nearly two weeks and then healed completely, but a good deal of induration remained at the abscess site and signs of small-bowel obstruction persisted—namely, moderate distension, visible peristalsis, and a succussion splash. A radiograph (*Fig.* 712) in the erect position confirmed these findings, with fluid levels and gas present as far down as the lower ileum.

A laparotomy was carried out through a left subumbilical paramedian incision. To the right of the midline omental adhesions were divided and farther laterally dense bands were divided, freeing two loops of ileum from the anterior abdominal wall. There was definite evidence of kinking at this site, with partial obstruction. Dissection among the loops of terminal ileum demonstrated the calcified mass adherent to the posterior abdominal wall and posterior layer of the small-bowel mesentery. On clearing further, the mass was found lying within the distal half of the appendix. Just proximal to it a necrotic area of the wall was opened and a sinus demonstrated continuous with the lumen of the appendix. The appendix complete with calculus was removed intact and the stump invaginated into the cæcal wall. A corrugated rubber drain was inserted and the wound closed. The post-operative period was uneventful and he was discharged on the fourteenth day.

DESCRIPTION OF CALCULUS.—This measured 2·5 cm. in diameter and weighed 8 g. On section there were concentric laminæ with a central core which was soft and pulpy. Chemical examination showed the contents of the outer layers to be mainly calcium phosphate and the central core was vegetable matter containing only a trace of cholesterol. There was no bilirubin. (*Fig.* 713.)

The distal portion of the appendix had obviously been acutely inflamed. The site of perforation was proximal

FIG. 712.—Straight radiograph of abdomen in the erect position, showing distended small bowel loops and fluid levels.

to the calculus. The proximal half of the appendix appeared normal on macroscopical section.

Comment.—There were many interesting features about this case and a review in retrospect provides a different picture from that whilst under investigation. From the size of the calculus and its position a tentative diagnosis was made of a gall-stone which had ulcerated out from the ileum to cause the abscess and partial small-bowel obstruction. But for this to have happened an attack of complete intestinal obstruction must surely have occurred with impaction in the lower ileum to precede such an ulceration. Complete obstruction did not occur, but in view of the continuing partial obstruction a barium meal and follow-through to screen the lower ileum was not thought advisable. The adhesions found at operation around the cæcum and terminal ileum made it easy to understand why this area could not be filled with a barium enema. Doubtless a cholecystogram would have shown a normal gall-bladder outline and absence of fistula to the small bowel.

A pre-operative diagnosis of appendiceal calculus was not made.

Case 2.—A. C., female, aged 44 years, was admitted to hospital on April 30, 1949. She had complained of abdominal pain for two days. This began in the epigastrium and settled into the right iliac fossa in about twelve hours. The pain persisted and spread subsequently to

the left iliac fossa. There was nausea but no vomiting and the bowels were constipated.

She had had no previous attacks of abdominal pain and, apart from a subtotal hysterectomy for fibroids in 1947, she had been perfectly well until the onset of the present illness.

ON EXAMINATION.—The temperature was 100·4° F. and the pulse 100 per minute. The tongue was furred and the breath fœtid. Heart and lungs were normal. The abdomen was rigid in both iliac fossæ, with tenderness maximum in the right iliac fossa. No mass was palpable. Rectal examination showed marked tenderness in the pouch of Douglas.

A diagnosis was made of pelvic peritonitis due to acute appendicitis.

AT OPERATION.—The abdomen was opened through a gridiron incision. There was a small amount of seropurulent fluid in the pelvis and scattered areas of exudate

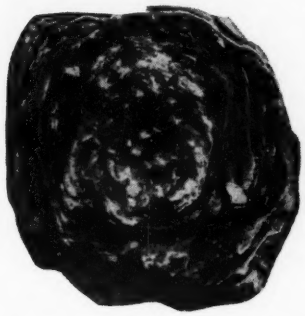

FIG. 713.—Cross-section of the calculus, showing concentric laminations and pulpy central core. (× 2¼.)

were found on the cæcum. The appendix was retro-ileal and adherent near the tip to the posterior abdominal wall above the brim of the pelvis. When delivered it was found to be nearly 6 in. long and contained a calculus nearly 2 cm. in diameter lying in the proximal half about 1 in. from the cæcum. A small abscess was present in the meso-appendix continuous with a perforation just distal to the calculus. The appendix was removed and the stump buried in the cæcum. A small corrugated drain was inserted to the bed of the appendix and the wound closed.

PROGRESS.—Apart from superficial infection of the wound she made an uninterrupted recovery. She was seen in the follow-up clinic four weeks after discharge from hospital, and had remained perfectly well.

DESCRIPTION OF CALCULUS.—A rounded, concentrically laminated stone, 2 cm. in diameter and weighing 5 g. The cut section and chemical composition were exactly similar to the first case.

A radiograph (*Fig.* 714) taken post-operatively shows the features of the calculus, which is impacted at the proximal end and distending the lumen of the appendix. The local abscess is shown just distally. The laminations are not so clearly defined as in *Case* 1.

Comment.—This patient presented after forty-eight hours' abdominal pain with a typical attack of appendicitis with perforation and pelvic peritonitis. No pre-operative radiograph was taken as there were no unusual features about the case.

DISCUSSION

It is necessary to define the condition described as an appendiceal calculus, and this term is meant to imply that the calcified mass originates in the appendix. In earlier writings on appendicitis there was a good deal of confusion about the terminology of the different types of organic matter which are found in the appendix, and such terms as concretions, fæcoliths, moulds, enteroliths, and coproliths were used without any clear distinction being made between them. It has long been agreed that calcified radio-opaque elements can occur in the appendix. Barry in 1906 made out a case for the origin of such elements within the appendix, although, from a study of the literature, it is evident that current thought leaned to the belief that the nucleus must be preformed, e.g., a gall-stone or foreign body.

It is obvious that any stone greater than 1 cm. in diameter must have originated within the appendix itself, and the following explanation for their origin and development has been postulated. The appendix normally contains a secreting mucosa. Stasis

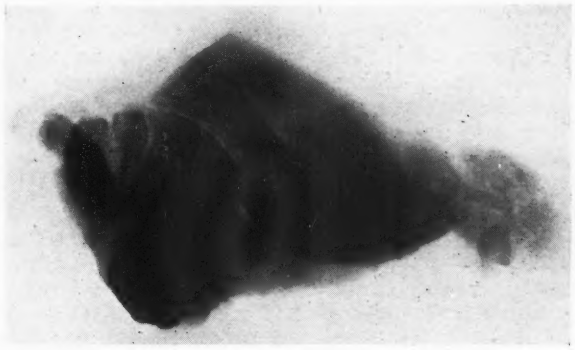

FIG. 714.—Radiograph of the stone in the appendix after removal. The stone is lying near the proximal end, and the soft-tissue swelling above it is a localized abscess in the meso-appendix.

leads to inspissation of the fæcal contents, which in turn will cause irritation with secretion of mucus. The mineral salts in the mucus will precipitate on any nucleus present. Once the process has commenced, steady growth can be expected, and a very large calculus or multiple calculi may result. The study of the chemical composition of such calcified elements by Williams (1907), and later by Maver and Wells (1921), shows that in the majority of cases the hard outer shell is composed of calcium and magnesium phosphate and that the soft central core is mainly vegetable pulp containing mucus and large numbers of bacteria, but no cholesterol, bile-salts, or pigments. This composition differs from that of gall-stones or true enteroliths.

True calculi of the appendix are uncommon. Bunch and Adcock (1939) give the figure as one case in two thousand cases of appendicitis, and compared with the non-radio-opaque fæcoliths they are rare. According to Felson and Bernard (1947) slightly over one hundred cases have been reported since 1900, the majority in foreign literature. This number is sufficient to draw attention to the fact that such a condition does occur, and must be borne in mind in the differential diagnosis of calcified lesions on the right side of the abdomen.

Stones may be small, multiple, and faceted, or large, single, and laminated. Very few authors have made a correct pre-operative diagnosis, and differentiation was from kidney or ureteric calculi, and gall-stones in the gall-bladder or impacted in the lower ileum. Wells has laid stress on the diagnosis from calcified ileocæcal lymph-glands, but most stones present a smooth surface with a regular

outline in a radiograph unlike that of calcified glands. The degree of mobility of a stone within the appendix is important, but this will vary with the presence or absence of adhesions binding the appendix to surrounding structures.

Levi (1934) reported a case in which the radiographic shadow suggested a stone in the lower pole of the right kidney. Pyelography showed it to be outside the urinary system. At operation a very long appendix was found containing a calcium phosphate stone attached to the lower pole of the right kidney. Coleman (1944) reported a case in a child with a definite appendicitis with peritonitis but subsidiary urinary symptoms sufficiently severe for a plain radiograph of the abdomen to be ordered. This showed an elliptical shadow in the vicinity of the lower right ureter overlying the sacrum. Laparotomy was carried out and a perforated appendix was removed. Subsequent X-ray examination of the appendix showed a radio-opaque fæcolith of the same shape as in the previous radiograph of the abdomen, and this same shadow was absent on repeat X-ray examination of the abdomen.

Tripodi and Kruger (1943) report a case where the diagnosis was made of a gall-stone in the terminal ileum. A barium meal and follow-through radiograph showed a normal terminal ileum. The appendix was filled with barium in its proximal portion and then appeared to extend out into the stone. A pre-operative diagnosis of appendiceal calculus was made and confirmed at operation.

In these competitive days there is always a tendency to produce a record, and Packard's case in 1921 seems to be the largest recorded, with a stone 1 × 2 × 4 cm. and weighing 8 g., although Bunch and Adcock (1939) have recorded one of 2·75 cm. in diameter in all directions and weighing 13·5 g. It is interesting that in Packard's case extrusion of the calculus occurred by pressure necrosis and had caused no local surrounding inflammation.

Felson (1949) has carried out investigations on the actual incidence of calculi in acutely diseased and normal appendices. He quotes Bowers as having done a comparable study, and arriving at similar conclusions. The findings showed that in 75 acutely inflamed appendices 33·3 per cent showed radio-opaque material. In 183 normal appendices only 2·7 per cent showed calculi. The radiographs were taken of the appendices after removal from the abdomen and an attempt made to determine from the size and density of the shadow whether they would be visible in a plain film of the abdomen. There seem to be too many variable factors to make a definite statement on the value of such figures, but it is probable that the incidence given is unusually high.

The relationship of such calculi to appendicitis must be considered. A great deal of discussion on the aetiology of appendicitis has taken place, and a good deal of it is now only of historical interest. Appendiceal calculi can be placed among the numerous foreign bodies found in the appendix, which include dental fillings, toothbrush bristles, grape stones, lead shot, etc. All such elements have been held responsible for causing appendicitis. It is now agreed that they play some part in the course of acute appendicitis and may lead to earlier perforation once inflammation has commenced, but that they may not necessarily be its original cause. Some authors (Wangenstein and Bowers, 1937) still believe that such elements are the primary cause. However, in cases of giant calculi, as reported by Packard (1921) and Bunch and Adcock (1939), appendicitis had not occurred and changes in the appendix were caused by pressure necrosis. Felson and Bernard (1947) state in their review that appendiceal calculi were associated with acute appendicitis in more than 90 per cent of the cases and that perforation occurred in almost 50 per cent. Felson has stressed the point that in all the cases in which the relative location of the calculus was recorded, perforation occurred distal to the calculus. In the two cases reported in this article, acute appendicitis with perforation occurred in each case. In *Case* 1 the perforation was proximal, but in *Case* 2 the perforation was distal to the calculus. In each case the appendix distal to the calculus was the seat of acute inflammation and the shorter proximal portion appeared normal. In neither case did attacks of abdominal colic occur during the growth period of the stone. It is strange that such a large calculus can exist in a small viscus without associated inflammation. Presumably the growth is very gradual and impaction does not occur and drainage of secretions can pass by the side of the stone. If infection does not arise then the conditions should be favourable for the development of a mucocele, but no such condition has been described in the reported cases.

SUMMARY

Two cases of large appendiceal calculus are reported. In each case acute appendicitis with perforation occurred, one with formation of a local abscess and the other with general peritonitis. A short review of the literature is given, but no attempt has been made to make it complete. Over one hundred cases of appendiceal calculi have been reported. The incidence of radio-opaque elements in the appendix may well be higher than was previously thought. Their relation to acute appendicitis is discussed briefly. There is a high incidence of appendicitis in cases with calculus, and the risk of perforation in such cases is increased.

My thanks are due to Dr. Pygott for the barium enema and radiographs, and to Mr. T. G. I. James and Mr. J. G. Bonnin for their help with the first case and advice in the preparation of this report. Also to Mr. A. Booker and Miss B. Buckle for the preparation of the radiographic prints.

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REGIONAL COLITIS AS AN ACUTE ABDOMINAL EMERGENCY

A REPORT OF THREE CASES

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REPORTS of cases simulating regional colitis of the non-specific type have appeared in the literature since the beginning of this century, descriptions being given, for example, by Moynihan (1907), Mayo Robson (1908), and Dalziel (1913). The condition was more completely investigated, both clinically and pathologically, by Moschowitz and Wilensky (1923), while Crohn (Crohn, Ginsburg, and Oppenheimer, 1932; Crohn and Berg, 1938) contributed important papers wherein he showed that the conditions of regional ileitis and regional colitis were by no means uncommon. Bargen (1943) and others interested in ulcerative colitis have referred to a distinct type, comprising somewhat less than 10 per cent of all cases of ulcerative colitis, in which the lesion is regional or segmental in distribution, and these closely resemble certain of the cases of regional colitis described by Crohn and the earlier writers.

Recourse has been had to surgery in the majority of those cases only after a preliminary period of observation and investigation, as a result of which a tentative diagnosis was made, enabling a planned operative procedure to be carried out. The purpose of this paper is to emphasize the fact that regional colitis may present as an acute abdominal emergency in a patient who has hitherto been perfectly well; laparotomy may have to be undertaken with the minimum of preliminary investigation, while the history, signs, and symptoms may be such that even a provisional pre-operative diagnosis of regional colitis is unlikely.

Regional ileitis is a condition which is frequently considered when exploring the acute abdomen, and, should it be found unexpectedly, little difficulty will be experienced in making the diagnosis, and in dealing with the situation along recognized lines. There has been less guidance in the case of regional colitis, as it has not yet won the same recognition as the cause of an acute abdominal emergency. This lack of awareness may lead to difficulties during a laparotomy in regard to both diagnosis and treatment.

During the past two years the writer has met with three cases of regional colitis which have come to operation as acute abdominal emergencies. Curiously enough, the site of the lesion has been towards the distal end of the transverse colon on each occasion. In no instance was a correct pre-operative diagnosis made, and it must be admitted that at laparotomy in one of the cases the diagnosis was faulty, a circumstance which led to embarrassment in the later treatment of the patient. So protean are the pathological changes in regional colitis that the presenting signs and symptoms are correspondingly most diverse; this is illustrated well when the pre-operative diagnoses are detailed—mesenteric vascular occlusion, acute intestinal obstruction from carcinoma of the colon, and perforated peptic ulcer, respectively.

CASE REPORTS

Case 1.—Mrs. H. McM., a housewife aged 65, was admitted to hospital on March 2, 1948, with a complaint of abdominal pain and vomiting of twenty-four hours' duration.

HISTORY.—The pain was colicky in nature and central abdominal in position. Vomiting, which began shortly after the onset of the pain, became increasingly frequent, and the vomitus, at first bile-stained, became dark brown in colour. The bowel had not moved, nor had flatus been passed, for twenty-four hours, and the last motion passed contained dark red blood. Previous to this the stools had never been blood-stained.

Previous History.—In 1943 the patient was operated upon for the removal of a large tumour arising from the left ovary. Although pathological examination showed that the tumour was a simple cyst of the ovary, the presence of scattered nodules on the peritoneum of the adjacent pelvic viscera led to a grave prognosis—the patient being given six months to live. Since then, however, her health had been good, her appetite excellent, and the bowels regular.

ON EXAMINATION.—The patient was a thin, frail-looking woman in obvious pain. Temperature 98·8° F.; pulse 110; respirations 20. The tongue was dry and furred, the breath foul.

Distension of the abdomen was noted, but there was no visible peristalsis. On palpation there was marked tenderness and rigidity just above and to the left of the umbilicus, where a mass could be felt, sausage shaped, with the long axis lying transversely across the abdomen (this was more readily appreciated under anæsthesia). Splashing was elicited over this area and vigorous peristal ic sounds were heard on auscultation. On rectal examination, blood was noted on the examining finger, but no tumour was palpable.

Radiologically, a straight film of the abdomen, in the standing position, showed a localized gaseous distension of the bowel near the splenic flexure, associated with a fluid level.

As internal strangulation or mesenteric vascular occlusion seemed likely, arrangements were made for laparotomy. Continuous gastric suction was begun and fluid replacement was instituted by means of an intravenous saline drip.

AT OPERATION.—Under general anæsthesia, the abdomen was opened through a right paramedian incision. There was clear free fluid in the peritoneal cavity, and the mass which had been felt was found to involve the last 3 in. of the transverse colon. Here, the serosa was bright red in colour and covered with flakes of fibrin. The segment was dilated, with fluid lying stagnant within the lumen. The bowel wall was thickened, but soft and friable. The mesocolon was slightly thickened and contained discrete enlarged glands, soft and elastic. The inflammatory changes gradually diminished at either end; the intense redness of the serosa gave way to mottling and the wall gradually thinned till the bowel became normal again. The terminal ileum and the colon proximal to the inflamed part were dilated, suggesting that a local ileus was present in this segment. The distal colon, as far as could be seen, was normal and no other pathology was found in the abdominal viscera.

A loop of transverse colon, proximal to the lesion, was brought out through the upper end of the incision

as a colostomy, with a view to averting perforation, relieving obstruction, and resting the inflamed bowel. The parietal incision was closed, and a Paul's tube was inserted into an opening made in the summit of the colostomy loop.

PROGRESS.—Convalescence was uneventful. Chemotherapy in the form of penicillin and sulphamezathine

FIG. 715.—*Case* 2. Straight film of abdomen. Obstruction at splenic flexure, and inspissated fæcal material in cæcum and ascending colon.

was given for four days; drip and suction were discontinued after forty-eight hours; the colostomy acted on the third day, and she was up on the ninth day.

The palpable mass in the abdomen gradually diminished in size and disappeared.

Sigmoidoscopic examination showed no abnormality in the lower sigmoid colon or rectum. Radiological examination by means of a barium enema, carried out on March 18, showed no abnormality in any part of the colon, barium passing freely from the rectum to the colostomy opening.

She was discharged from hospital on March 22.

Since then, she has been in good health and the colostomy gives the minimum of trouble. As the inflammatory process appears to have resolved completely, closure of the colostomy has been recommended, but she feels so well that she has steadfastly refused to have any further operation.

Case 2.—Mrs. S. M., a housewife aged 43, was admitted to hospital on Dec. 12, 1947, complaining of abdominal pain and vomiting for two days.

HISTORY.—Seven weeks prior to admission she was delivered of her first child. Since the confinement she had felt occasional colicky pains in the centre of her abdomen, and also difficulty with her bowels, although a movement was obtained each day with the aid of a laxative.

Two days before admission, however, the pains became more frequent and increasingly severe, while the constipation became absolute. Vomiting also set in, at first bile-stained, later with the appearance of coffee-grounds.

Previous History.—Her general health had always been good. She had not suffered from diarrhœa, and had not noticed blood, mucus, or pus in the stools at any time.

ON EXAMINATION.—She was a healthy looking woman. Temperature 97·8° F.; pulse 80; respiration 20. The tongue was moist.

The abdomen was very distended, with increased fullness in the right iliac fossa. There was no visible peristalsis.

On palpation there was slight tenderness in the epigastrium, no mass was felt, but there was intestinal splashing over the centre of the abdomen. On auscultation vigorous peristaltic sounds were heard. Rectal examination was negative.

Radiologically, a straight film of the abdomen showed distension of the colon proximal to the splenic flexure, while the colon below this level was not outlined, suggesting an obstruction near the splenic flexure. An opacity on the right side, conforming in shape to the outline of the colon, had the appearance of inspissated fæcal matter in the cæcum and ascending colon (*Fig.* 715).

On a diagnosis of acute intestinal obstruction, arrangements were made for immediate laparotomy.

AT OPERATION.—Under general anæsthesia the abdomen was opened through a right paramedian incision. Clear fluid escaped from the peritoneal cavity; the cæcum and ascending and transverse colon were greatly distended; the small intestine was dilated to a lesser extent. The site of the obstruction was found to be in the transverse colon just short of the splenic flexure. Here, the omentum was attached to the colon by inflammatory adhesions. Although the lumen was felt to be narrowed, the bowel wall was thickened, the whole giving the impression of a soft cellular tumour of the bowel. There was, however, no nodularity, nor were enlarged glands present in the mesocolon, and no distant metastases were found. The pelvic colon was easily examined and it presented no abnormality, nor did palpation of the descending colon reveal any pathological change.

Despite these somewhat anomalous findings, the cause of the obstruction was thought to be a carcinoma of the colon; a loop colostomy was formed, by bringing out part of the right half of the transverse colon through the upper end of the incision, after the remainder was

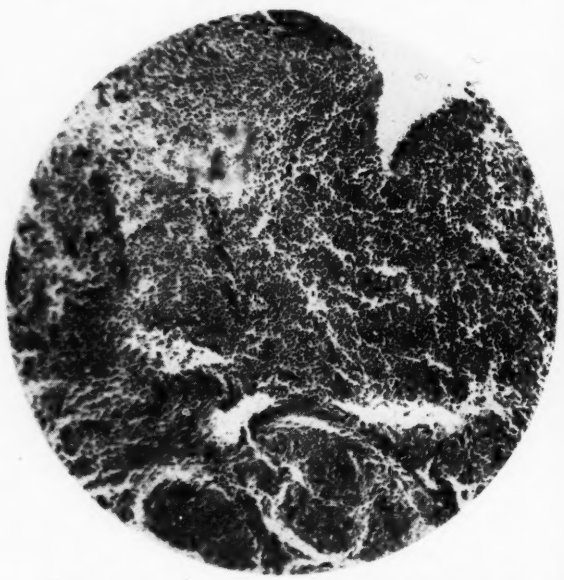

FIG. 716.—*Case* 2. Microphotograph, low-power, showing infiltration of bowel wall with polymorphs and round cells, mainly in submucosa and mucosa. The latter has lost its glandular structure.

closed. The colostomy was opened and a Paul's tube was inserted.

PROGRESS.—Recovery from the operation was uneventful and three weeks later further operation for resection of the tumour was performed.

SECOND OPERATION (Mr. R. Leslie Stewart).—On Jan. 2, 1948, under general anæsthesia, the abdomen was

opened through a left paramedian incision. The gross findings of the previous operation were confirmed, but when the mass of omentum was freed from the colon, the latter was found to be greatly narrowed for about an inch, and the stricture was thought to be simple. The stricture was resected along with an inch of normal colon on either side, and the continuity of the bowel was restored by end-to-end anastomosis, using one layer of interrupted linen stitches. The abdomen was closed in layers without drainage.

PATHOLOGICAL REPORT (Dr. R. F. Ogilvie).—" Macroscopic: the specimen consists of a 3-cm.-long segment of large bowel. The segment has an unusually narrow lumen and is particularly narrowed about its middle; section shows that the wall is thickened, firmer than usual, and apparently replaced by pale yellow material. The mucous aspect incidentally is roughened and apparently ulcerated. A small part of attached fatty mesentery is normal.

" Microscopic: The mucous membrane has lost its glandular structure and is heavily infiltrated with polymorphs and round cells, the former being especially numerous near the surface. The submucous, muscular, and subserous regions are irregularly overrun with polymorphs, round cells, fresh blood, and old blood-pigment, while the subserous coat is greatly thickened by œdema. No malignancy is present in the section. The condition is ulcerative colitis ". (*Figs.* 716, 717.)

She made a quick recovery from this operation and was discharged on Jan. 31.

SUBSEQUENT PROGRESS.—A radiological examination of the distal colon by means of a barium enema was carried out on Feb. 24. The barium flowed freely to the colostomy opening, but two areas of narrowing were noted, one in the position of the anastomosis and one in the proximal part of the descending colon. The intervening bowel showed an absence of haustration. The remainder of the colon presented a normal appearance.

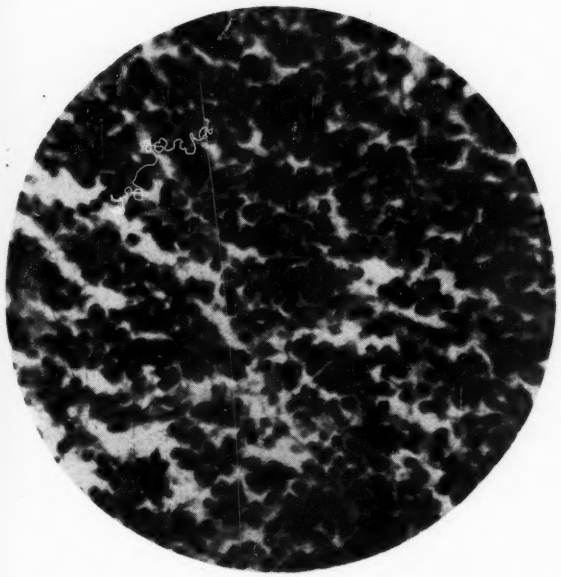

FIG. 717.—*Case* 2. Microphotograph, high-power, showing the dense concentration of round cells and polymorphs in the submucosa.

It was reported that " The appearances are neither spastic nor neoplastic and suggest a fibrosis, the nature of which is uncertain ". (*Fig.* 718.)

Since then the patient has been in excellent health. Further radiological examinations have been carried out, and though some improvement has been noted, the areas of stenosis persist.

It is now felt that the condition is stationary, and it is proposed to carry out as wide a resection as possible to remove the stenosed areas, with subsequent closure of the colostomy.

Case 3.—J. H. S., a male aged 45. Occupation—civil engineer. Admitted to hospital at 5 a.m. on Sept. 1, 1948, with severe abdominal pain of two hours' duration.

FIG. 718.—*Case* 2. Barium enema, showing narrowing in transverse colon (site of anastomosis) and in descending colon.

HISTORY.—The onset of the pain was so sudden as to be dramatic. The pain was generalized, constant, and made worse by any movement. There was no vomiting or diarrhœa.

During the previous week he had been ' out of sorts ', with loss of appetite, a tendency to constipation, and vague abdominal pain under the left costal margin. The temperature had risen each evening to about 100° F.

Previous History.—This was not helpful. He had enjoyed excellent health, with good digestion and a regular bowel habit. He had never had diarrhœa, nor had he noticed blood, pus, or mucus in the stools at any time. There was no loss of weight. During the recent war he served in Egypt, but contracted no intestinal troubles there.

ON EXAMINATION.—He was a well-built man in good condition, but obviously in severe pain. Temperature 99·8° F., pulse 90, respirations 25. The tongue was moist but dirty.

The abdomen, which was not distended, did not move with respiration. On palpation, there was generalized tenderness and rigidity, with no point of maximal tenderness. No mass was felt and there was no loss of liver dullness. Rectal examination was negative.

The provisional diagnosis was perforated peptic ulcer with general peritonitis and immediate operation was undertaken.

AT OPERATION (6 a.m., Sept. 1).—Under general anæsthesia, the abdomen was opened through a right upper paramedian incision, splitting the right rectus. The peritoneal cavity contained a copious amount of purulent fluid. The source of infection was found to be at the splenic flexure of the colon. Here, the bowel, for 3–4 in., was the site of an angry inflammatory mass, soft and friable, and exuding pus from its surface. Dense inflammatory adhesions fixed the splenic flexure to the posterior abdominal wall. Owing to the friability of the mass and the numerous adhesions it was felt that exteriorization was not devoid of risk, and a right transverse

colostomy was performed through the upper part of the incision. The limbs of the colostomy were sutured together for two inches with interrupted stitches of linen to provide a spur, and complete exclusion of the affected bowel was obtained by placing two Payr's clamps on the apex of the loop and completely severing the bowel between them, after the remainder of the incision had been closed.

Post operation, continuous gastric suction with intravenous fluid replacement was carried out for twenty-four hours. The proximal clamp was removed after forty-eight hours and the distal after five days. Chemotherapy in the form of penicillin and sulphamezathine was employed for one week.

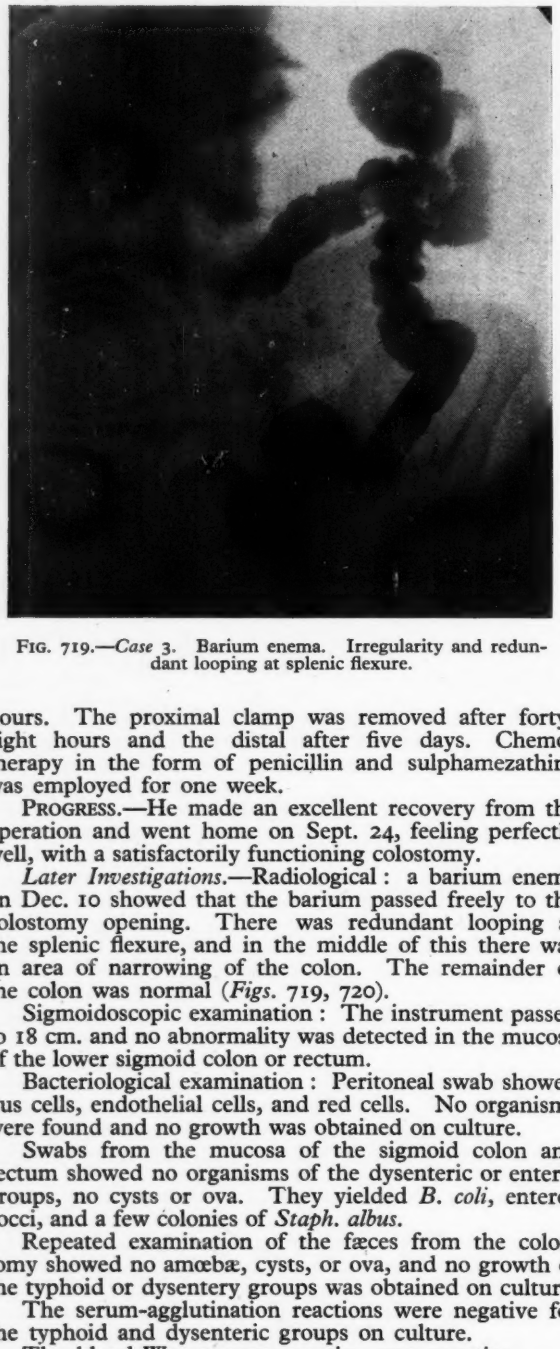

FIG. 719.—*Case* 3. Barium enema. Irregularity and redundant looping at splenic flexure.

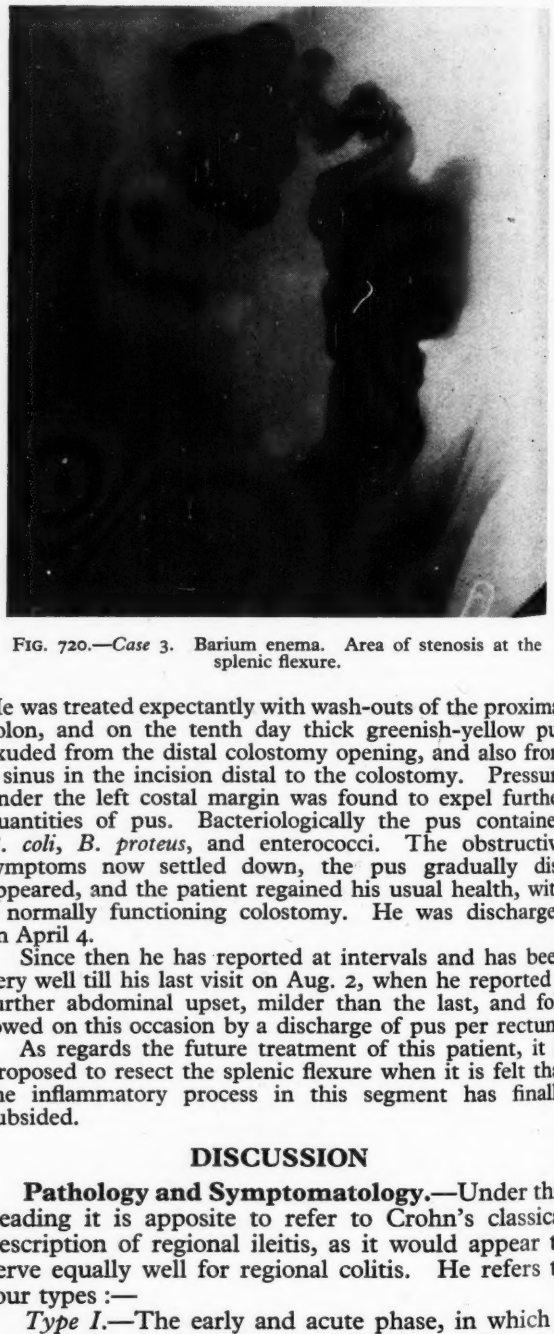

FIG. 720.—*Case* 3. Barium enema. Area of stenosis at the splenic flexure.

PROGRESS.—He made an excellent recovery from the operation and went home on Sept. 24, feeling perfectly well, with a satisfactorily functioning colostomy.

Later Investigations.—Radiological: a barium enema on Dec. 10 showed that the barium passed freely to the colostomy opening. There was redundant looping at the splenic flexure, and in the middle of this there was an area of narrowing of the colon. The remainder of the colon was normal (*Figs.* 719, 720).

Sigmoidoscopic examination: The instrument passed to 18 cm. and no abnormality was detected in the mucosa of the lower sigmoid colon or rectum.

Bacteriological examination: Peritoneal swab showed pus cells, endothelial cells, and red cells. No organisms were found and no growth was obtained on culture.

Swabs from the mucosa of the sigmoid colon and rectum showed no organisms of the dysenteric or enteric groups, no cysts or ova. They yielded *B. coli*, enterococci, and a few colonies of *Staph. albus*.

Repeated examination of the fæces from the colostomy showed no amœbæ, cysts, or ova, and no growth of the typhoid or dysentery groups was obtained on culture.

The serum-agglutination reactions were negative for the typhoid and dysenteric groups on culture.

The blood-Wassermann reaction was negative.

Radiographs of the chest were negative for tuberculosis.

Subsequent Progress.—On Jan. 15, 1949, he reported with colicky pains in the abdomen and lessened movement of the colostomy. There was no distension of the abdomen. He was admitted for three days: castor oil by the mouth, and colon lavage through the proximal colostomy opening completely relieved these signs of subacute obstruction. On March 1, 1949, he was readmitted with colicky pain, more severe this time, and associated with vomiting and abdominal distension. Temperature 101° F.; pulse 74. During the next ten days the colostomy did not act properly, the abdominal distension persisted and the low-grade pyrexia continued. He was treated expectantly with wash-outs of the proximal colon, and on the tenth day thick greenish-yellow pus exuded from the distal colostomy opening, and also from a sinus in the incision distal to the colostomy. Pressure under the left costal margin was found to expel further quantities of pus. Bacteriologically the pus contained *B. coli*, *B. proteus*, and enterococci. The obstructive symptoms now settled down, the pus gradually disappeared, and the patient regained his usual health, with a normally functioning colostomy. He was discharged on April 4.

Since then he has reported at intervals and has been very well till his last visit on Aug. 2, when he reported a further abdominal upset, milder than the last, and followed on this occasion by a discharge of pus per rectum.

As regards the future treatment of this patient, it is proposed to resect the splenic flexure when it is felt that the inflammatory process in this segment has finally subsided.

DISCUSSION

Pathology and Symptomatology.—Under this heading it is apposite to refer to Crohn's classical description of regional ileitis, as it would appear to serve equally well for regional colitis. He refers to four types:—

Type I.—The early and acute phase, in which a small segment of reddened and thickened bowel is found, and a peritoneal reaction is present which gives rise to symptoms.

Type II.—The stage of mucosal ulceration, giving rise to frequent stools containing mucus and blood.

Type III.—Narrowing of the intestinal lumen, due to fibrosis, leading to symptoms of intestinal obstruction.

Type IV.—In which abscesses and fistulæ form, producing a variety of symptoms according to their progress and spread.

The cases under review aptly illustrate each of the types, with the exception of *Type II*; and the absence of symptoms associated with this type has been a most significant feature of the cases.

Case 1 may be taken as an example of *Type I*, exhibiting a small segment of acutely inflamed transverse colon, bright red in colour, thickened and dilated, with enlargement of the related lymph-glands. In such cases the thickening is due to œdema affecting chiefly the submucosa and subserosa. Clinically the features were those of generalized intestinal colic, tenderness and rigidity over the affected colon, which was palpable, and over which splashing could be elicited. The passage of blood per rectum was a noteworthy finding. When such changes affect the lower ileum a diagnosis of acute appendicitis is usual, while in this case mesenteric vascular occlusion or internal strangulation were thought to be the likeliest possibilities. Following a proximal colostomy the local signs regressed completely and a later radiological examination showed that the colon was perfectly normal. This suggests that resolution of the inflammation had occurred without permanent organic damage.

Case 2 is an example of Crohn's *Type III*, in which stenosis is the outstanding feature. From the inflamed appearance of the omentum at operation and from the abundance of polymorphs in the microscopical section, it seems probable that an acute exacerbation of the colitis precipitated the obstruction. The mucous membrane and the submucosa were strikingly affected, being infiltrated with numerous polymorphs and round cells, and the glandular structure of the mucosa had disappeared. The muscular coats were affected to a lesser extent, but the œdema of the subserosa added to the thickness of the bowel wall. Barium enema yielded the important information that the descending colon as well as the transverse colon was involved in the pathological change, a fact which was not appreciated on clinical examination.

The extraordinary feature of this case is that such advanced changes should be present in the bowel without any history of intestinal upsets. Diarrhœa with blood and pus might have been expected. The insidious character of the onset of regional or segmental ulcerative colitis has been stressed by Bargen (1943). In discussing ulcerative colitis, he states: "The regional form of 'chronic ulcerative colitis' presents the most bizarre picture, has the least clear-cut manifestations, and offers the greatest diagnostic difficulties of any of the types of the disease." He distinguishes the regional form of ulcerative colitis from generalized or thrombo-ulcerative colitis, in which the lesions spread proximally throughout the large bowel from the rectum and sigmoid colon, and in which frequent stools containing blood, mucus, and pus are invariable features. Indeed, he considers that the regional form differs widely, aetiologically, pathologically, and in its clinical course, from the generalized form. The similarity in nomenclature tends to be confusing, and perhaps regional colitis rather than regional ulcerative colitis would be a more suitable descriptive term.

Case 3, where the features were general peritonitis associated with an acute inflammatory mass at the splenic flexure, corresponds to Crohn's *Type IV*. Here, as there is no specimen from which the precise pathology can be deduced, a surmise must be made from the clinical findings. Low-grade pyrexia for a week, with upper abdominal pain, preceded the sudden onset of general peritonitis. A barium enema three months later showed a narrowing of the lumen at the splenic flexure; eight months later, following a few days of subacute obstruction and pyrexia, pus discharged from the distal colostomy opening; eleven months later, following a milder attack of obstruction, pus discharged per rectum.

It seems likely that the train of events was as follows: In the course of a chronic symptomless stenosing regional colitis, an acute inflammatory reaction occurred, with the formation of a paracolic abscess, which ruptured subsequently into the general peritoneal cavity. At laparotomy, no actual perforation of the bowel was seen, and there was no fæcal content in the peritoneal cavity. Two secondary exacerbations occurred, with similar abscess formation eight months and eleven months later. In the former the abscess discharged into the bowel lumen, and from there to the distal colostomy opening, and also tracked to discharge through the abdominal incision. In the latter, the abscess again burst into the bowel lumen and discharged per rectum on this occasion. During these attacks the patient presented the signs and symptoms of subacute intestinal obstruction, due in all probability to inflammatory adhesions of the small bowel occasioned by the paracolic abscess.

Diagnosis.—In the cases described, operation was a matter of urgency, and it is difficult to see how a correct diagnosis might have been reached beforehand. At laparotomy the diagnosis can only be provisional; the acute case, as *Case* 1, with soft, elastic, enlarged glands, should present least difficulty; in *Case* 2, the obstructive type, the absence of irregular induration of the bowel and the lack of characteristic enlarged glands should exclude the commoner condition of carcinoma; but in *Case* 3, when there was an acute inflammatory mass, to differentiate from diverticulitis without radiological examination is impossible.

In the subsequent confirmation of the diagnosis the barium enema is of great value. In the early stage no change is seen, but as the disease advances a constant area of narrowing appears. Until a late stage is reached, no barrier to the passage of barium presents.

Briefly the following conditions must be excluded:—

The dysenteries by examination of the stools and the serum-agglutination reactions.

Thrombo-ulcerative colitis by the absence of a history of the typical blood-stained and pus-laden stools, by the absence of lesions on sigmoidoscopic examination, and the extent of the lesion on barium enema examination.

Syphilis by the negative Wassermann reaction.

Actinomycosis by the absence of the fungus in the discharges.

Tuberculosis, perhaps most difficult, by the absence of tuberculous lesions elsewhere, and by the site of the error in the bowel.

Diverticulitis by the absence of the characteristic extralumenar shadows on barium enema examination.

Carcinoma by the absence of the irregular filling defect and obstruction on radiological examination.

Valuable as those aids to diagnosis are, finality is only reached when the affected bowel is examined pathologically after resection.

Treatment.—Corbett (1945) states that regional colitis confined to the left colon is a firm indication for temporary transverse colostomy, which should in all cases be followed by a local resection. Few, I imagine, would not agree that this may be taken as the basis of treatment, but a review of the cases reported, in which emergency treatment had to precede elective treatment, raises some interesting points.

Attention must be drawn towards the difficulty experienced in estimating the extent of the lesion. In forming a plan of procedure, it is essential to know how much of the colon is involved. In *Case* 2 the associated lesion in the descending colon escaped notice, despite a careful review of the whole of the colon. A barium enema was required to reveal the second area of constriction. In the same case, following resection of the affected segment in the transverse colon, narrowing recurred at the site of the anastomosis, demonstrating the necessity for an extensive resection of the inflamed bowel. Wide enough resection will now be difficult, and a lateral anastomosis will probably now have to suffice. A cæcostomy originally would have made the resection a much easier procedure, although the irritation of the fæcal stream might have prevented such a satisfactory amelioration of the inflammatory process. The obstructive type, however, is from its very nature a slowly progressive lesion, and for such cases a cæcostomy would be quite justifiable. Whereas in the more active type, as in *Case* 3, with an abscess probably communicating with the bowel lumen, complete transection to defunction the affected segment is essential; if, in such cases, transverse colostomy will render later resection difficult, ileostomy, not cæcostomy, is the treatment of choice. Summing up, transverse colostomy, while the ideal emergency treatment for most cases, must not prejudice the later resection. A sufficiently long segment of bowel, which is indubitably normal, must intervene between the colostomy and the area of regional colitis. If this cannot be done, a cæcostomy or ileostomy according to circumstances must be performed.

The type of colostomy is worthy of note. In all cases complete transection of the bowel, by some manœuvre similar to that employed in *Case* 3, is preferable to a loop colostomy. This not only puts the inflamed colon at rest immediately and more effectively, but also helps to prevent spread of the disease to the proximal colon. The tendency to 'jump' the colostomy has been noted in thromboulcerative colitis, and in regional colitis the possibility cannot be ignored. Spread is presumed to be by direct continuity of tissue, taking place mainly in the submucosa where the infection is most active. Garlock (1941) goes further; he considers that spread occurs also by the lymphatics in the subserosa and in the mesocolon; he therefore practises complete division of the mesocolon as well as the colon, and implants the stomata through separate incisions in the parietes. In any case of regional colitis the future cannot be foretold, and there is the possibility that a colostomy may have to remain a permanency; to guard against spread to the proximal colon, it is a simple precaution to sever the bowel completely when the colostomy is performed.

Is there a place for conservatism in the treatment of those cases of acute regional colitis where the lesion is an early one? This is a most interesting question, and one to which the answer could only be supplied by further experience. That acute regional ileitis may resolve spontaneously is well known. Koster, Kasman, and Sheinfeld (1936) have followed up 8 such cases, where the diagnosis was made at laparotomy, the abdomen was closed, and a complete recovery without recurrence ensued; while Mailer (1938) considers that conservative treatment is indicated for the acute case of regional ileitis. That the problem arises also in acute regional colitis is demonstrated in *Case* 1. Following proximal colostomy the colon is apparently completely restored to normal, so that there appears to be little risk attached to simple closure of the colostomy. The test of cure suggested by Hurst (1940), in which a suspension, in water, of fæcal material from the proximal loop of the colostomy is injected daily into the distal loop, for two to three weeks, would be of value in such a case. Whether or not the colostomy might have been omitted is a matter for conjecture. It was found that there was a local ileus in the affected segment and it was felt that the combination of distension and inflammation might lead to perforation. The decision, therefore, to perform a proximal colostomy was probably well founded.

The period which must elapse between the initial colostomy and further operative treatment requires careful consideration. The period will naturally vary according to the pathology. In *Case* 1 closure of the colostomy could probably have been undertaken after a few weeks, whereas *Case* 3, after almost a year, still shows signs of active inflammation, and resection must be deferred. From the small experience of those patients, the conclusion is drawn that the inflammatory process in the colon may take many months to resolve and that there must be no precipitancy in re-opening the abdomen for resection. Hurst's procedure, referred to above, would be of great assistance in arriving at a decision to carry out the second stage of operative treatment.

Other operative procedures which must be considered are lateral anastomosis and exteriorization. In *Case* 2 it is probable that lateral anastomosis will be carried out, as the presence of inflammatory adhesions may make an adequate resection impossible. Following a wide review of regional ileitis, Garlock and Crohn (1945) have found that lateral anastomosis, with transection of the ileum above the lesion, resulted in an appreciably lower mortality and a lesser recurrence rate than any other operative procedure. Resection, however, in the colon, preceded

by a colostomy, should be attended with little risk, and it would be logical to suppose that eradication of the diseased bowel would most effectively prevent recurrence.

Primary exteriorization, while superficially attractive, is unlikely to be an easy procedure owing to the degree of pericolitis present. This circumstance would certainly have made this type of operation extremely difficult and hazardous in *Cases* 2 and 3. A further defect of this method is that a later investigation may show that other areas of the colon are affected, and the exteriorization of one segment only might make the subsequent removal of all the diseased bowel unnecessarily difficult. It is felt, therefore, that exteriorization can have little place in the emergency treatment of regional colitis.

In brief, the line of treatment suggested for the acute case of regional colitis is transverse colostomy with complete transection of the bowel, always providing that this will permit of a later resection. Should this be in doubt, a cæcostomy or ileostomy should be performed. Further treatment depends upon whether or not the colon is permanently damaged. Should it return to normal, simple closure of the colostomy is indicated. If there are signs of irreversible changes in the colon resection is the treatment of choice.

Prognosis.—Judging from the cases treated, the immediate prognosis is good. Only one patient, *Case* 3, has given rise to any anxiety from a recurrence of the colitis, and his attacks are diminishing in severity. The ultimate prognosis would also appear to be favourable if successful resection can be achieved. "Once the disease has been eradicated surgically, the danger of recurrence is minimal" (Bargen).

SUMMARY

1. Regional colitis may present as an 'acute abdomen'.

2. Three such cases are described.

3. In no case was there a previous history suggestive of disease of the colon.

4. The symptomatology, pathology, diagnosis, and treatment are discussed.

My thanks are due to Mr. R. Leslie Stewart for help and encouragement in the preparation of this paper, and for permission to publish the details of the three patients, who were admitted to the Royal Infirmary, Edinburgh, under his care.

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CARCINOMA OF THE EPIDIDYMIS

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CARCINOMA of the epididymis is rare and of considerable interest to both surgeons and pathologists. The most difficult problem it presents is that of diagnosis. Clinically the lesion is likely to be mistaken for epididymitis; pathologically it has to be differentiated from other epididymal tumours that at first sight appear to be malignant: and even when malignancy is certain, the classification of the tumour is far from easy. Because of the misleading histological appearances, it is uncertain how many of the reported cases should be considered authentic; Ferrier and Foord (1934) summarized reports of 15 cases, including 1 case of their own. In the literature that has appeared since the paper of Ferrier and Foord, we have found only 4 cases that are sufficiently well described to be accepted with confidence; it will be convenient to give abstracts of the descriptions, under the names of the reporters:—

Thompson (1936), *Case* 36. Aged 38. A swelling of the left testis had been present 3½ years. The left testis was four times the normal size. The whole epididymis was involved by white, solid-looking, moderately firm tumour about the same size as the testis. Microscopically the growth was "a carcinoma of a high grade of malignancy with little differentiation of cells". The patient's later history was unknown.

Thompson (1936), *Case* 37. Aged 53. A swelling of the right testis had been noticed two months previously. The right testis was approximately the size of a lemon (about 7 cm. long). At operation a firm yellowish-white tumour of the epididymis was found. Microscopically it was "a carcinoma of a high grade of malignancy" with virtually no differentiation of the cells. There was no evidence of recurrence or metastasis a year later.

Gordon-Taylor and Till (1938). Aged 66. A right vaginal hydrocele was present and posteriorly the testicle was much enlarged and stony hard. Orchidectomy was performed. "The epididymis was 2½ in. long and 1 in. in diameter at the globus minor, narrowing towards the caput; the vas deferens ended in tumour tissue. There were a few small cysts." Microscopically the tumour consisted of rather loosely arranged cells with dark oval nuclei and scanty cytoplasm. No recurrence was found up to 18 months later.

Ibrahim (1947). Aged 21. A swelling of the scrotum was noticed about a year before. The right scrotum contained a firm nodular mass about four or five times the size of a normal testicle. Microscopically the growth was a typical seminoma. Death occurred about five months after operation, metastases being detected radiologically in bones and lungs.

In the present paper we report a further case and discuss the problems of clinical and pathological diagnosis.

CASE REPORT

A man aged 39 was admitted to Manchester Royal Infirmary complaining of a swelling and a feeling of heaviness in the left testicle. The swelling had been present for five months and had gradually enlarged, though the patient said it had become rather smaller in the past three weeks. It had always been hard and painless, but there had been a dragging feeling in the lower lumbar region. There were no urinary symptoms or cough ; the patient thought he might have lost a little weight in the past twelve months.

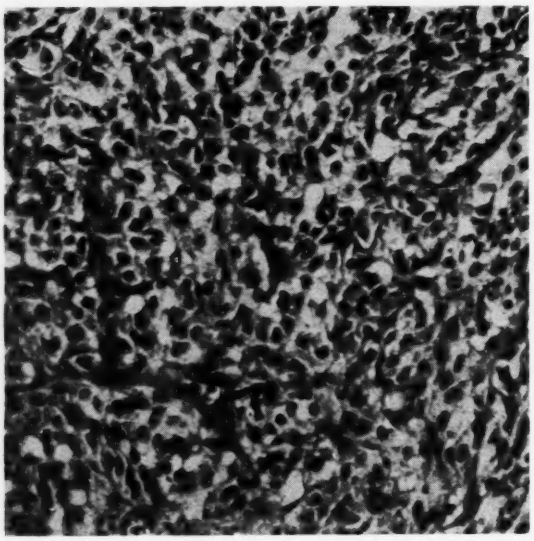

FIG. 721.—Solid mass of tumour cells without structural pattern. (× 180.)

FIG. 723.—Interlacing strands of tumour cells simulating a 'mixed parotid tumour'. (× 180.)

ON EXAMINATION.—The patient looked healthy, and apart from the testicular lesion the only abnormality was a blood-pressure of 180/130. The left epididymis showed a hard craggy swelling mainly involving the body and globus minor. The swelling was not attached to the scrotum. The vas was thickened and beaded. On rectal examination the prostate was found to be normal and the seminal vesicles could not be felt. A twenty-four-hour specimen of urine was examined for tubercle bacilli and cultured, in each case with negative results. The Wassermann reaction was negative. There was no radiological evidence of a pulmonary lesion.

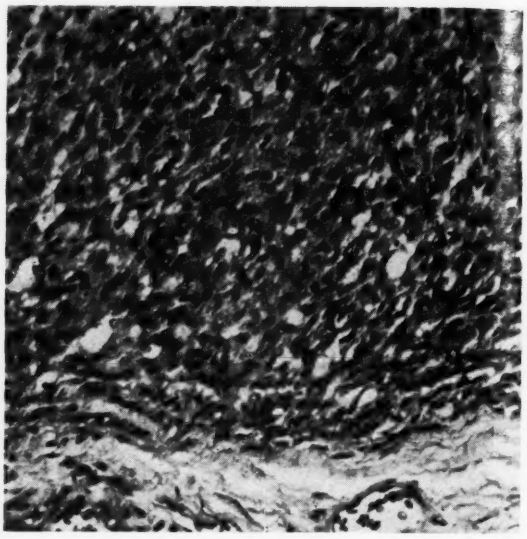

FIG. 722.—Mass of growth clearly demarcated from normal tissue, which occupies lowest fifth of figure. (× 180.)

DIAGNOSIS.—The lesion was thought to be epididymitis, either tuberculous or non-specific, but probably tuberculous in view of the painless onset, hard craggy epididymis, and beaded vas. Points against the diagnosis were the absence of a palpable vesicle and of any other sign of tuberculosis. The possibility of neoplasm was not considered.

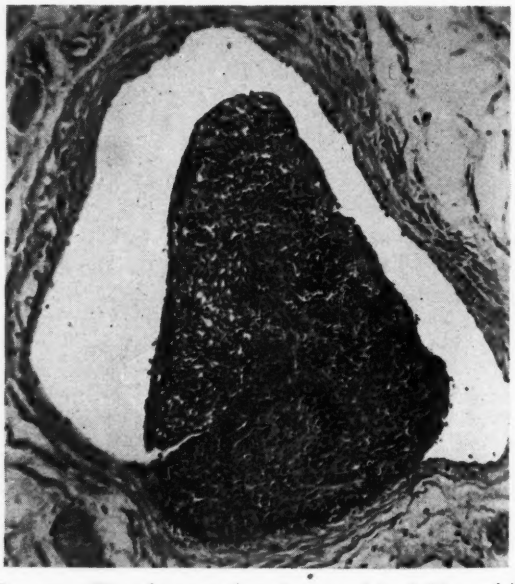

FIG. 724.—Plug of tumour tissue in a vessel (probably a vein). (× 100.)

OPERATION AND LATER HISTORY.—Left orchidectomy was performed. The patient made good progress and

was discharged in ten days. Six weeks later he was admitted to a medical ward complaining of severe headaches, present for twenty years, but worse since the operation. The blood-pressure was now 220/150. There was some papillœdema, which was thought to be due probably to hypertension but possibly to cerebral metastases. The patient's condition gradually deteriorated and he died five months after operation. In the week before death severe hæmoptysis occurred; X-ray examination of the chest showed hazy opacities in the lungs, but it was uncertain whether these were secondaries or inflammatory lesions. There was a leucocytosis of 15,000–20,000, but the cerebrospinal fluid was normal. Permission for an autopsy could not be obtained.

DESCRIPTION OF TUMOUR.—The epididymis formed a rounded mass about the same size as the testis, which was of normal size. When cut open, the epididymis showed near the lower pole an irregular whitish caseous area about 1 cm. in diameter; microscopically this proved to be an area of necrosis in a tumour, which was otherwise well preserved.

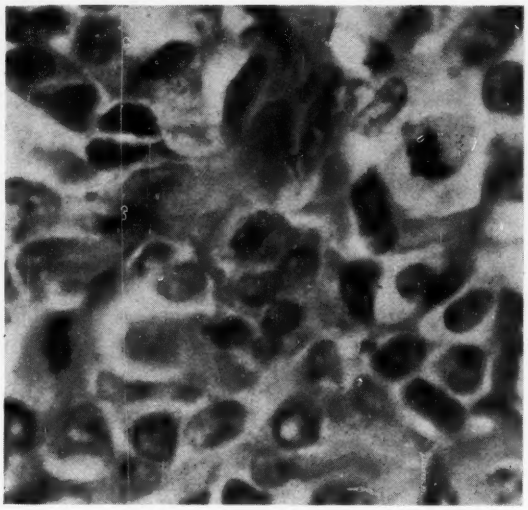

FIG. 725.—Tumour tissue showing two mitotic figures. (× 800.)

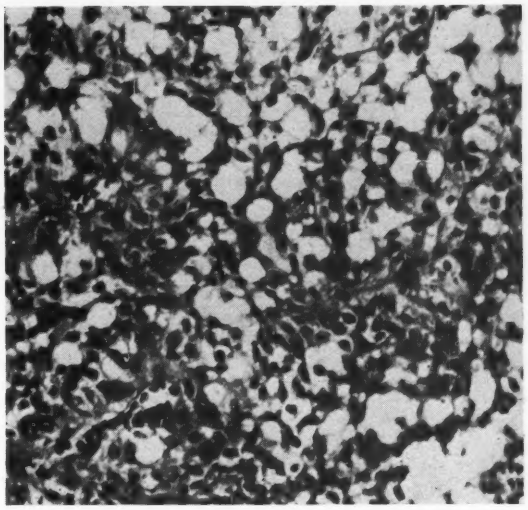

FIG. 726.—Tumour tissue showing extensive vacuolation. (× 180.)

In paraffin sections stained with hæmalum and eosin, most of the tumour was seen to be arranged in large, rounded, well-defined cell masses without structural pattern (*Figs.* 721, 722); in one part of the tumour, however, the cells were arranged in interlacing strands, the picture being indistinguishable from that of a 'mixed parotid tumour' (*Fig.* 723). The large masses of tumour cells contained well-formed capillaries consisting of a single layer of endothelial cells. Plugs of tumour were seen in vessels—probably veins, though some may have been lymphatics (*Fig.* 724). The tumour was composed of small cells with oval nuclei and ill-defined cytoplasm and showed numerous mitotic figures (*Fig.* 725). Much of the tumour tissue was vacuolated (*Fig.* 726), but it was uncertain whether the vacuoles were within or between the tumour cells. The necrotic area showed hæmorrhage and infiltration with polymorphonuclear leucocytes; it also contained fat which was demonstrated in sudan-stained frozen sections. Fat in other parts of the tumour was probably too scanty to account for the vacuoles seen in the paraffin sections.

The testis showed no abnormality, either macroscopically or microscopically.

Nature of the Tumour.—The caseous area seen in the fresh specimen suggested that the lesion was tuberculous epididymitis; microscopical examination left no doubt that it was a malignant tumour. The exact nature of the growth was not obvious and it was reported as a seminoma, although the appearances were not typical. Further study leads us to the conclusion that the tumour would be best described simply as a carcinoma of the epididymis. The points supporting the diagnosis of malignancy were: (1) the predominant mode of growth, namely in large cell masses; (2) the presence of numerous mitotic figures; and (3) the presence of tumour tissue in vessels. Confirmatory evidence in the form of proved secondary deposits was unfortunately lacking; the opacities in the lungs noted on X-ray examination shortly before death might possibly have been due to inflammation. The absence of any discoverable lesion in the testis made it virtually certain that the growth originated in the epididymis, though it was impossible to determine which particular constituent element of the epididymis was responsible.

The tumour bore a general resemblance to the tumours described by Hinman and Gibson (1924, *Case* 3); Eisenberg, Simons, and Wallerstein (1932); Coleman, Mackie, and Simpson (1932); Ferrier and Foord (1934); Thompson (1936, *Cases* 36 and 37); Gordon-Taylor and Till (1938); and Ibrahim (1947). It did not seem to be identical with any of them; in particular, the 'parotid' pattern seems to be peculiar to our tumour. This pattern, namely that of interlacing strands of cells, is unexplained, but may possibly have been due to invasion of tough tissue by the growth or to sclerosis of masses of tumour cells.

DISCUSSION

Clinical Aspects of Epididymal Carcinoma.—The occurrence of a tumour in the epididymis is so unusual that such a diagnosis is rarely considered when the nature of a swelling in this organ has to be determined. On the other hand, inflammatory swellings of the epididymis are exceedingly common; for this reason the only problem usually considered is the nature of the presumed infection. Since tuberculosis is most likely to be present as a painless epididymitis, it is natural that most epididymal neoplasms, which may also be painless, should be generally regarded as tuberculous. Perhaps the most valuable sign of a tuberculous epididymitis is a coincident enlargement of the seminal vesicle,

which of course is not enlarged if the swelling is a tumour.

One of us (A. F. W.) treated a similar lesion in a soldier. He was thought to have a non-specific epididymitis, but since the swelling did not decrease in size during a period of several months, an orchidectomy was performed and a seminoma reported. In the light of our case, this may have been primary in either the testis or the epididymis. The two cases together suggest that epididymal tumours are commoner than they are supposed to be, and that if a lesion considered to be a non-specific epididymitis fails to pursue the usual course of gradual improvement, surgery should not be too long delayed.

From a study of the published cases an idea of the clinical picture of carcinoma of the epididymis can be formed. Half the cases occur between the ages of 20 and 40, and the left and right epididymides are affected with approximately equal frequency. The patient complains of a painful or painless swelling of the testicle, often present for less than a year. The growth is not infrequently accompanied by a hydrocele, but a varicocele is rare. Metastases occur, especially in the lungs. Patients frequently die within two years after diagnosis, and so far only one is known to have survived more than five years. The usual treatment is orchidectomy, but it would be logical to give deep X-ray therapy to the regional glands in addition, as for tumours of the testis.

Pathological Aspects of Epididymal Carcinoma.—The chief pathological problems in connexion with epididymal carcinoma are those of diagnosis and nomenclature. The best evidence of the malignancy of an epididymal tumour is the histological demonstration of metastases in organs remote from the scrotum; since the lungs are sites of election for metastases, these organs should be examined with special care both radiologically and at necropsy. When the growth is confined to the scrotum the histological diagnosis may be less certain and is especially difficult when the appearances are suggestive of adenocarcinoma. The problem has been greatly clarified as the result of an important study by Golden and Ash (1945). Under the term 'adenomatoid tumour' these authors described 15 cases of a distinctive type of benign growth characterized by gland-like spaces in a fibrous stroma. It shows no evidence of local invasion or distant metastasis and mitotic figures are rare. Such growths have been reported under a variety of names and have often been regarded as malignant. Golden and Ash thought that the cases reported by Hinman and Gibson (1924) and Thompson (1936) as adenocarcinomas of low malignancy were probably adenomatoid tumours and we are of the same opinion.

Malignant growths of the epididymis are not infrequently diagnosed pathologically as seminoma, and the appropriateness of this name may well be questioned. The application of the term 'seminoma' in any particular case probably means that the tumour was morphologically indistinguishable from, or closely similar to, the common round-cell tumour of the testis. The fact of the resemblance is not in question, and it was to convey this that the original diagnosis in our own case was seminoma. Despite this morphological resemblance, however, it seems undesirable to apply the name of a primary tumour of the testis to growths believed to have originated elsewhere. Eisenberg, Simons, and Wallerstein (1932) preferred the term 'spheroidal-cell carcinoma', although they admitted that such a growth might possibly develop from ectopic testicular tubules. There are obviously several possible tissues of origin for carcinomas arising in the epididymis and there is no means of identifying them in the individual case. It would accordingly be best to apply purely morphological designations. When the term 'adenocarcinoma' suggests itself, the possibility that the growth may be an adenomatoid tumour should of course always be carefully considered.

SUMMARY

A case of carcinoma of the left epididymis in a man of 39 is described and discussed with reference to previously published cases. The growth consisted of small cells with oval nuclei and resembled seminoma of the testis, but in parts it simulated a 'mixed parotid tumour'. The patient died five months after orchidectomy.

If a case presumed to be a non-specific epididymitis fails to improve, surgical intervention is indicated.

Benign adenomatoid tumours of the epididymis have often been mistaken for adenocarcinomas and should always be excluded before the diagnosis of malignancy is made.

Although carcinomas of the epididymis may resemble seminomas of the testis, it is preferable that they should receive purely morphological designations.

We are indebted to Professors S. L. Baker and A. M. Boyd for advice and criticism and to Mr. F. Ward for the photographs.

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MEDIASTINAL NEUROBLASTOMA IN AN INFANT

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CASE REPORT

R. C., a male infant aged 3 months, was referred to me on May 24, 1948, by Dr. James Thomson, Pædiatrician, Dundee Royal Infirmary, and Dr. Scott, of Alyth.

HISTORY.—This child had been noticed to sweat profusely since birth. He was an only child and the birth was natural, at full term. He was breast-fed up to the age of six weeks, but did not thrive. The feeds were supplemented by cows' milk diluted. He was then put on 5 feeds of 6 oz. National Dried Milk, gaining weight on this diet. He could not be induced to take orange juice.

On the night of May 12 he was awake all night whimpering and sweating; he slept well on Thursday, May 13, and Friday, May 14, but did not sleep after 6 a.m. on Saturday, May 15, on which day he was admitted to the Medical Children's Wards with anorexia. He vomited frequently in small amounts, bringing up wind. Bowels were regular and normal, including the motion on the day of admission.

From that time till transfer to my care he had a variable temperature with intermittent pyrexia, vomiting, and sweating. He was fed by œsophageal drip and given penicillin and sulphonamides as it was thought that there might be infection from a recently vaccinated arm which looked sore and pneumonia was suspected.

ON EXAMINATION.—The child was gravely ill with rapid respiration. Fontanelles were depressed, but the skin was of normal texture and the eyes were not sunken. There was no noticeable cough, no œdema, and no jaundice. There was dullness to percussion over the lower lobe of the left lung, with diminished breath-sounds in the dull area. The apex beat was in the nipple line. Other systems were normal.

On May 18 an X-ray examination of the chest was carried out and a large mass was discovered in the posterior mediastinum displacing the heart and mediastinum to the right. A barium swallow also demonstrated that the œsophagus was much displaced. (*Figs.* 727, 728.)

AT OPERATION.—This was carried out on May 25. Dr. Janet Leng administered gas–oxygen–ether sequence. An incision was made over the ninth left rib, which was freely resected subperiosteally and the pleural cavity was opened to expose a solid tumour. This was adherent to the parietes but not to the lung and was enucleated digitally without much difficulty. It was uncertain whether it took origin from the chest wall or had become adherent. The wound in the chest wall was closed with deep sutures of catgut and skin sutures of silkworm gut without drainage.

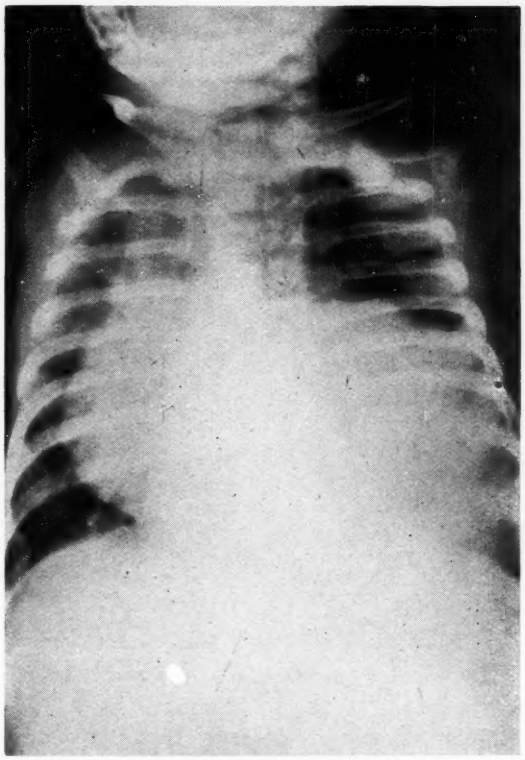

FIG. 727.—Plain X-ray film taken May, 1948.

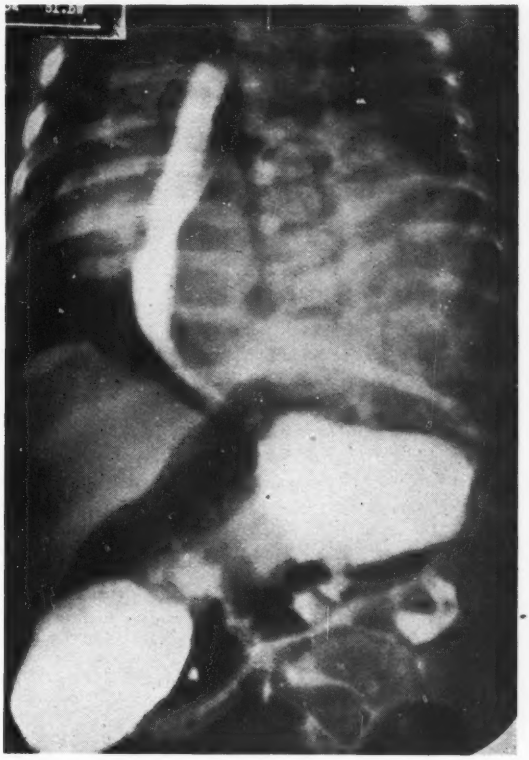

FIG. 728.—Immediately after swallowing barium. (May, 1948.)

After-treatment and Progress.—Penicillin was administered up to May 30. On June 14 the child was thriving well, taking normal feeds, and weighed 11 lb. 6 oz.

Further X-ray examination at this date showed some mottled opacities in the lower left chest, with amorphous calcareous deposit in the pleura. A barium swallow showed only slight deviation of the œsophagus. The child left hospital on June 25, 1948, apparently well.

PATHOLOGICAL REPORT.—Professor Lendrum, in a preliminary report, stated that this was a highly cellular malignant growth of sarcomatous type, composed of pleomorphic cells in a fibrillar matrix.

A further report from Professor Lendrum in March, 1949, suggested that the tumour had taken origin in the

sympathetic nervous system. He remarks: "the fact that the progress of the lesion has been restrained is surprising in view of the primitive nature of some of the cells, but differentiation toward ganglioneuroma may be occurring in the postulated remnant."

Commentary and Subsequent Progress.—The first histological report was not received till a month after the patient's discharge. At this time the child was free from symptoms and thriving well.

The question of X-ray therapy was considered. It was tempting to make assurance doubly sure by employing this treatment, but, in my opinion, X-ray therapy in the very young may have unknown effects on the growing cells, and, in view of the good progress of the patient, it was decided to await events.

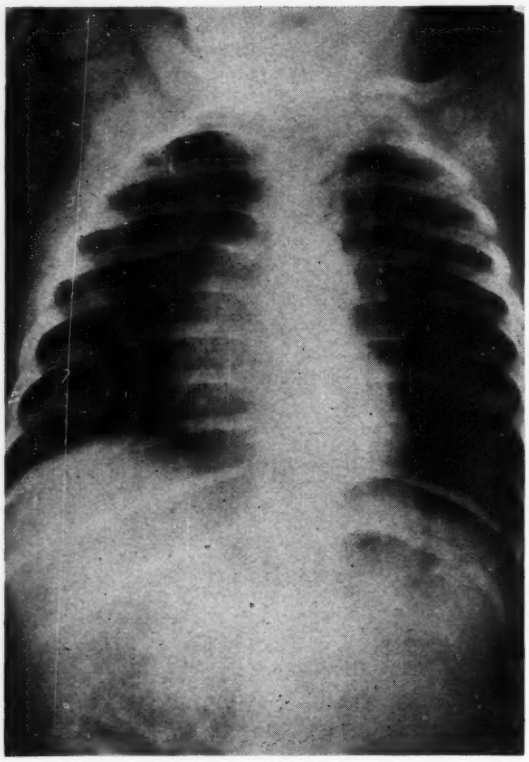

FIG. 729.—Plain film showing gap in 9th rib. (May, 1950.)

FIG. 730.—Immediately after swallowing barium. (May, 1950.)

Since the operation the child has been examined from time to time, the last occasion being on May 21, 1950. He appears to be in good health and is thriving normally.

X-ray examination shows that the heart is still slightly displaced to the right side. There is no evidence of any intrathoracic growth and the œsophageal picture following a barium swallow is normal (*Figs.* 729, 730).

Illingworth and Dick (1949) distinguish between neurocytoma, or neuroblastoma, a tumour the cells of which are poorly differentiated and arise from the nerve-cells proper and not from the glia, and ganglioneuromata, where the cells of the tumour are fully differentiated. The former grow rapidly and the latter take a benign course.

The benign ganglioneuroma is found in the neck, the abdomen, and less commonly in the mediastinum, 17 cases of intrathoracic tumour being recorded. The mediastinal tumour is described as congenital or beginning in early life.

Malignant neurocytoma or neuroblastoma is more common in the adrenal medulla or the retroperitoneal tissues. Metastases to the liver and orbit frequently occur, and the growth is not amenable to treatment by operation or radiotherapy (Wright, 1910).

Willis (1948) states that 50 per cent of tumours in children under 2 years of age take origin from undifferentiated proliferating neural tissue of developing sympathetic ganglia or renal medulla. He believes that initially malignant tumours may undergo transformation into relatively benign tumours (ganglioneuroma). Wells (1940) notes similar transformation of neuroblastoma into ganglioneuroma.

It would appear, therefore, that a regression of malignancy might have taken place in this patient.

Illingworth and Dick state that undifferentiated tumours may become differentiated. They also publish an illustration of a ganglioneuroma of the mediastinum in a child, but no history is appended.

SUMMARY

A case of neuroblastoma of the mediastinum occurring in an infant of three months is described. The main clinical features were due to pressure symptoms on the lung and œsophageal displacement. The tumour was successfully removed by thoracotomy and the child is well and healthy two years after operation.

Mr. Douglas Allan, Technician, Surgery Department, is responsible for the prints.

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EXPERIMENTAL SURGERY

THE EFFECT OF TETRAETHYLAMMONIUM BROMIDE ON THE RETURN OF BLOOD-PRESSURE IN THE FEMORAL ARTERY DISTAL TO AN ACUTE OCCLUSION

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THE sudden occlusion of the main artery to a limb may lead to gangrene; the chief factor determining the survival of the tissues is the availability of an adequate blood-flow through the collateral vessels. Apart from anatomical variations, this is determined mainly by the number and size of these vessels and by the pressure gradient from above to below the site of occlusion. Spalteholz (1924) pointed out certain indispensable factors for the development of an adequate collateral circulation: (1) the occluded vessel must not be an end-artery; (2) the potential collaterals must be able to dilate—this implies that neither their walls nor their mouths are involved by organic disease; and (3) in gradual occlusion the state of the walls rather than the number and size of the arteries is of most importance. In sudden occlusion the two last named are of primary importance.

In order to avoid nutritional lesions when the collateral circulation is at first inadequate, measures may be taken to increase the size of the anastomotic channels, to maintain or to increase the systemic blood-pressure, and to prevent arterial spasm and consecutive thrombosis.

In recent years vasodilator chemical compounds have been introduced, which may be used in vascular disease to improve the collateral circulation. Tetraethylammonium bromide (T.E.A.B.) is one of a series of quaternary ammonium compounds which dilate arterioles by blocking the transmission of vasoconstrictor impulses in the autonomic ganglia. Hoobler, Moe, and Lyons (1949) found that in dogs these compounds produced an increase in femoral blood-flow. Lyons and others (1947), Hoobler and others (1947), and Malton and others (1948) consider that a similar action occurs in man.

The following experiments were undertaken to determine the arterial blood-pressure in the femoral artery distal to a ligature, without medication and

Table I.—PROXIMAL AND DISTAL BLOOD-PRESSURES FOLLOWING LIGATION OF THE FEMORAL ARTERY

CONTROL GROUP

HOURS AFTER LIGATION		EXPERIMENT								MEAN
		1	2	3	4	5	6	7	8	
½	P.	116	103	114	164	114	115	162	141	128·6
	D.	72	50	74	104	67	92	110	106	84·4
1	P.	126	110	112	162	112	120	158	142	130·2
	D.	78	58	68	108	70	110	124	116	91·5
1½	P.	108	100	122	150	114	114	158	143	126·1
	D.	72	58	84	102	77	104	128	117	92·8
2	P.	112	102	104	148	114	122	157	146	125·6
	D.	75	67	68	84	84	112	136	115	92·6
2½	P.	118	102	100	136	116	126	155	145	124·7
	D.	76	66	60	84	88	116	136	113	92·4
3	P.	117	102	106	126	116	125	159	147	124·7
	D.	77	65	60	84	89	115	141	107	92·4
3½	P.	120	105	112	120	—	126	155	150	127·0
	D.	76	65	58	80	—	116	143	108	92·3
4	P.	128	105	—	122	110	126	146	150	126·9
	D.	72	66	—	82	72	116	141	112	94·4
4½	P.	124	106	—	122	108	126	151	150	126·9
	D.	74	67	—	84	66	116	143	112	94·4
5	P.	121	112	—	122	112	122	146	146	125·9
	D.	75	65	—	84	72	115	140	108	94·1
5½	P.	—	114	—	—	108	122	140	144	126·0
	D.	—	62	—	—	72	118	134	105	98·2
6	P.	—	116	—	—	108	124	—	142	122·5
	D.	—	68	—	—	75	120	—	104	91·8

P, Proximal segment; D, Distal segment

after the administration of tetraethylammonium bromide.

Quiring (1949) considers that the speed with which collateral vessels establish normal pressure in the distal portion of an occluded vessel is a measure of their effectiveness, although measurements of blood-pressure in a given part of the circulation do not provide an exact indication of blood-flow.

PROCEDURE

Two groups of dogs were used, one as a control. Each animal was anæsthetized initially with intravenous nembutal (32 mg./kg.), and a uniform level of anæsthesia was maintained by further doses of 5–15 mg./kg. nembutal at intervals of one to two hours throughout the experiments. The animal was laid on its back and turned slightly towards the side opposite to that of the limb under investigation, in order to prevent pressure on collateral vessels in the gluteal region. The limb was loosely fixed to keep both hip and knee semiflexed. At the beginning of the experiment heparin was given intravenously in a dose of 250-300 i.u./kg., and half this dose was given after three hours.

The femoral artery was exposed well below the origin of the profunda (pudendo-epigastric trunk) from the external iliac artery. After double ligation and division cannulæ were inserted into the proximal and distal ends, and records of blood-pressure were made over several hours. In the T.E.A.B. series intramuscular injections of a 10 per cent solution, in doses of 2·5 mg./kg., were begun 30 minutes after occlusion and repeated half-hourly for varying periods (*Table II*). This dosage was chosen after preliminary experiments to determine the amount of the drug just insufficient to cause an appreciable fall in the systemic blood-pressure; the total of the repeated doses did not produce the undesirable effect of a lowered blood-pressure. In some animals, however, it was sufficient to cause toxic effects and even death.

RESULTS

1. Control Group.—Blood-pressure was recorded for six hours after ligation (*Table I*). In no instance did the mean systemic pressure fall below 100 mm. Hg. Throughout the period of observation no marked change in mean systemic pressure occurred, the range being from 122·5 mm. Hg to 130·2 mm. Hg. The range distal to the ligature was from 84·4 mm. Hg to 98·2 mm. Hg. The blood-pressure in the distal segment of the artery was lowest immediately after ligation, but rose gradually over a period of half to one and a half hours (*Fig.* 731), after which little or no further increase was recorded.

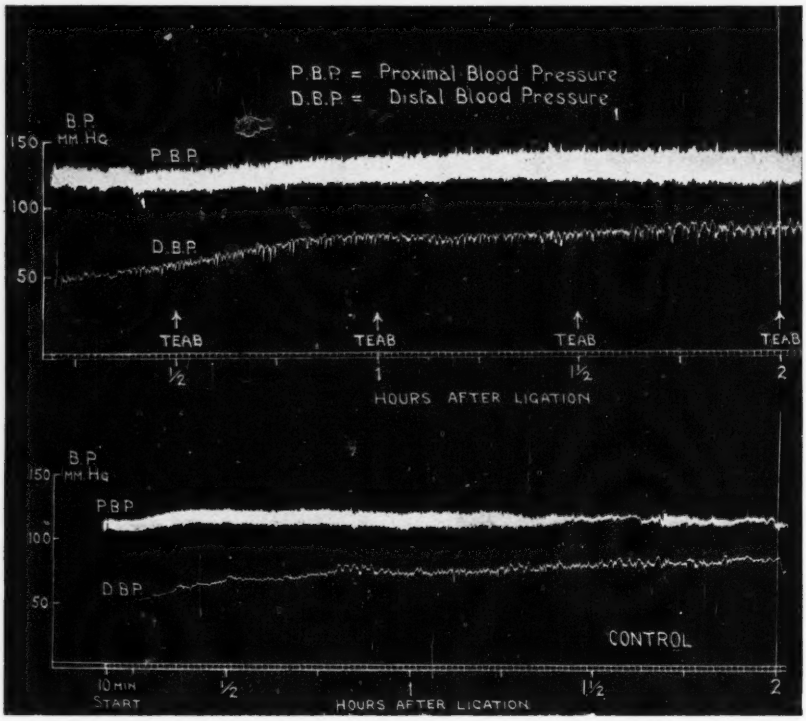

FIG. 731.—Records showing the gradual return of pressure and pulsation in the distal segment of the femoral artery in an animal from each group.

In every animal it was noted that, after the initial rise, the pressure in the distal segment varied directly with the systemic pressure. It was also noted that contraction of muscles causing either extension or flexion of the knee reduced the distal pressure by as much as 50 per cent, and that relaxation led to an immediate or rapid return to the initial pressure.

2. T.E.A.B. Group.—The mean systemic blood-pressure ranged from 123·2 mm. Hg to 131·5 mm. Hg, the lowest figures for each animal being recorded during the period of administration of the vaso-dilator compound (*Table II*). The mean distal pressure rose gradually for half to one and a half

hours after ligation and thereafter remained relatively constant (*Fig.* 731). The difference between collateral vessels and cannot be caused by the slight changes in systemic blood-pressure, which were

Table II.—PROXIMAL AND DISTAL BLOOD-PRESSURES FOLLOWING LIGATION OF THE FEMORAL ARTERY T.E.A.B. GROUP

HOURS AFTER			EXPERIMENT								MEAN
Ligation	T.E.A.B.		9	10	11	12	13	14	15	16	
½	—	P.	113	150	142	114	126	120	137	126	128·5
		D.	76	85	114	86	64	70	88	103	85·8
1	½	P.	116	150	147	120	132	123	142	122	131·5
		D.	88	86	130	104	84	73	110	104	97·4
1½	1	P.	121	150	138	116	135	124	139	121	130·5
		D.	89	103	126	102	85	74	120	110	101·1
2	1½	P.	121	140	134	115	133	118	139	112	126·5
		D.	97	98	122	104	88	70	122	101	100·2
2½	2	P.	131	140	137	109	127	116	135	112	126
		D.	105	102	128	92	86	68	125	104	101·2
3	2½	P.	125	136	139	110	132	117	132	114	125·8
		D.	112	101	128	96	92	65	122	108	103
3½	3	P.	124	133	127	110	128	120	132	112	123·2
		D.	105	100	114	96	94	68	124	108	101·1
4	3½	P.	128	126	126	109	128	122	132	—	124·4
		D.	100	90	111	91	95	68	125	—	97·1
4½	4	P.	129	124	128	114	133	—	134	—	127
		D.	108	87	114	98	96	—	123	—	104·3
5	4½	P.	127	120	134	—	140	—	133	—	130·8
		D.	107	76	128	—	102	—	123	—	107·2
5½	5	P.	126	—	122	114	138	—	134	—	126·8
		D.	101	—	105	93	104	—	121	—	104·8
6	5½	P.	132	—	124	109	140	—	133	—	127·6
		D.	106	—	108	90	105	—	118	—	105·4
Dose of I.M. T.E.A.B.	mg./kg.		5	5	2·5	2·5	2·5	2·5	2·5	2·5	
	Time		hrly.	hrly.	½-hrly.	½-hrly.	½-hrly.	½-hrly.	½-hrly.	½-hrly.	
	No. of doses		5	5	11	11	7	6	5	7	

P, Proximal segment; D, Distal segment

Table III.—STATISTICAL COMPARISON OF THE MEAN DISTAL BLOOD-PRESSURES IN THE CONTROL AND T.E.A.B. GROUPS

Hours after ligation	½	1	1½	2	2½	3	3½	4	4½	5	5½	6
Hours after T.E.A.B.	–	½	1	1½	2	2½	3	3½	4	4½	5	5½
Mean distal B.P. Controls	84·4	91·5	92·8	92·6	92·4	92·4	92·3	94·4	94·4	94·1	98·2	91·8
Mean distal B.P. T.E.A.B.	85·8	97·4	101·1	100·2	101·2	103·0	101·1	97·1	104·3	107·2	104·8	105·4
t =	0·14	0·51	0·74	0·71	0·76	0·92	0·71	0·21	0·72	0·72	0·47	1·6
P = between	0·9 0·8	0·7 0·6	0·5 0·4	0·5 0·4	0·5 0·4	0·4 0·3	0·5 0·4	0·5 0·8	0·5 0·4	0·5 0·4	0·7 0·6	0·2 0·1

For the difference in the mean distal pressures to be significant P must be less than 0·05

the mean distal pressures in the control and in the T.E.A.B. groups was not statistically significant (*Table III*).

DISCUSSION

After ligation and division of the femoral artery, a return of pressure in the distal part of the artery began in a few minutes. A constant level, varying from dog to dog, was reached after about one and a half hours and little further increase occurred during the subsequent four and a half hours. This initial rise of pressure must be due to dilatation of the occasionally in a downward direction. The mechanism of this dilatation is not known, but is possibly an effect of local anoxia. Eckstein, Gregg, and Pritchard (1941), using the femoral artery, found that the pressure and flow distal to the point of occlusion rose rapidly for a few hours and then more slowly until they approached those in the intact femoral artery. In this series, in several animals in both groups, pulsation was noticed in the distal segment within a few minutes. This confirms the findings of Eckstein and others but is not in agreement with those of Mulvihill and Harvey (1931).

The rapidity with which pulsation returns in the distal segment probably depends partly on the systemic pulse pressure and partly on the calibre of the collateral vessels at the time of occlusion. In addition to pulsations due to the heart's beat, rhythmic respiratory variations were noted.

With regard to the use of tetraethylammonium bromide, no significant improvement over the control series was found. The general impression gained as a result of its use was that a great variation in individual response existed, and that its action is therefore unreliable. This is in agreement with the findings of Pearl (1948).

CONCLUSIONS AND SUMMARY

Following sudden occlusion of the femoral artery in dogs, a severe fall of blood-pressure occurs in the distal segment. A return of pressure follows over the course of the next one and a half hours. After this period a new level is reached and is maintained with little variation for the following four to five hours.

In this series of experiments, improvement in the rate of return of blood-pressure was not produced by the intramuscular administration of tetraethylammonium bromide.

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SHORT NOTES OF RARE OR OBSCURE CASES

SOLITARY ECTOPIC PELVIC KIDNEY

WITH A REPORT ON A CASE ASSOCIATED WITH INCOMPLETE ROTATION OF THE GUT

BY T. J. BUTLER, BRISTOL ROYAL HOSPITAL

THE first observations on solitary ectopic pelvic kidney were made by Henot in 1830 during an autopsy on a child of 8 months whose sex was indefinite owing to absence of the genitalia. In 1937 Stevens collected all the recorded cases, the total at that time being 27. McCrea (1942) and Hanley and Steel (1947) continued the series, the latter authors bringing the total to 44 by adding 2 cases of their own. The purpose of this short communication is to add another example of the condition to the existing series of 52 cases already recorded in the world literature. *Table I* records the details of those cases which have been reported since the publication of Hanley and Steel in this journal.

CASE REPORT

A. K., a young man aged 24, was admitted to the Bristol Royal Hospital on April 27, 1950, with diffuse peritonitis, the illness being of forty-eight hours' duration. Although his symptoms were initially referred to the right and slightly above the level of the umbilicus, direct questioning revealed that during the previous few years the patient had suffered from periodic attacks of lower abdominal colicky pain, which was unrelated to meals or to defæcation nor associated with any upset of micturition.

In addition to the general signs of peritonitis, rectal examination revealed a firm, fixed, smooth, rounded, painless, mass lying in front of the rectum immediately above the level of the prostate. Urine examination showed no abnormality and the blood-pressure was 120/84.

Surgery was considered essential for the peritonitis, which was thought to be due to perforation following acute obstructive appendicitis. Since the initial symptoms were situated high in the abdomen, it was believed that the pelvic mass was not appendicular in origin.

AT OPERATION.—This was carried out under general anæsthesia—pentothal, nitrous oxide, oxygen, and ether. A right paramedian incision was made, revealing extensive soiling of the peritoneal cavity due to perforation of a gangrenous appendix, which was pre-ileal in position but occupying the upper right quadrant of the abdomen. The cæcum was undescended and mobile. It was noted that the jejunum, ileum, cæcum, and the rest of the colon as far as the splenic flexure all shared the same mesentery as in the fœtus. The appendix was removed and the peritoneal cavity emptied by suction.

Inspection of the pelvis revealed the mass to be a solitary ectopic kidney, lying along the right wall of the pelvis and resting on the pelvic floor. It projected into the bladder to a marked degree. The pelvic kidney measured about 7 in. in length, and the lower pole was about twice the size of the upper pole. The hilum faced upward, to the left, and slightly backward. The organ appeared to be quite fixed behind the pelvic peritoneum, the lower pole projecting between the rectum and the bladder. Some two or three vessels could be palpated running down from the aorta just above the bifurcation to the hilum of the kidney. No

kidneys could be palpated in the loins. After this inspection the abdomen was closed.

The patient made an uneventful recovery from this illness, and after three weeks had elapsed the urinary tract was investigated: (*a*) Urine: No abnormal constituents. (*b*) Blood-urea: 32 mg. per cent. (*c*) Urea concentration test: Normal. (*d*) Intravenous pyelography: This confirmed the absence of functioning renal tissue in the loin, and demonstrated the solitary kidney in the pelvis. The kidney was drained by one ureter of very short length. The renal pelvis showed a mild degree of hydronephrosis. The pyelogram is illustrated in *Fig.* 732.

Cystoscopy revealed absence of the left half of the trigone, whilst the right half of the bladder was obscured by the projection of the lower pole of the kidney. The right ureteric orifice could be seen on the crest of this projection, but a ureteric catheter would not pass into it for more than 3 cm. Following the intravenous injection of indigocarmine, efflux from the ureteric orifice occurred after eleven minutes had elapsed. This procedure also confirmed the presence of only one ureter. There was no detectable genital abnormality in this patient.

Comment.—The features of interest in this case are as follows: (1) The clinical presentation was that of generalized peritonitis, the pelvic mass being considered to be unrelated to the cause of the peritonitis. The identity of the mass as a solitary ectopic pelvic kidney was established at operation. (2) The associated lesion was incomplete rotation of the gut, i.e., failure of the third part of rotation. This particular abnormality has been recorded in association with a completely fused pelvic kidney at autopsy (Looney and Dodd, 1926).

SUMMARY OF THE KNOWN FEATURES OF THE CONDITION

Although the details given in all the records are not complete, study permits the following tentative conclusions to be made:—

Definition.—"An ectopic kidney is one that owes its position to developmental failure; it has been arrested in its ascent during embryonic life and has failed to rotate." (Thompson and Pace, 1937).

Frequency.—Thompson and Pace state that the frequency of all forms of renal ectopia is 1–10,000 of individuals, the pelvic variety being the most rare. Unilateral ectopic kidney appears to occur in 1–2000 autopsies (Forbes, 1945), whilst solitary ectopic pelvic kidney occurs in 1–22,000 autopsies (Stevens, 1937).

Sex Incidence.—Males and females appear to be equally affected. In 37 cases where the sex has been definitely established, 19 are females and 18 are males.

Anatomy.—In 36 cases in which full urological studies are recorded, the ectopic kidney is drained by one ureter in nearly two-thirds (in 22 of the 36 cases). The blood-vessels on the other hand are multiple in the vast majority of cases and arise from the neighbourhood of the aortic bifurcation. These vessels represent transient vascular supplies which normally disappear as the kidney ascends. The presence of a single vessel may predispose to torsion

Table I.—CONTINUATION OF SERIES OF CASES OF SOLITARY ECTOPIC PELVIC KIDNEY SINCE HANLEY AND STEEL (1947)

CASE NO.	AUTHOR	AGE	SEX	ABNORMALITIES	CLINICAL DIAGNOSIS	UROLOGICAL DATA	OPERATION	RESULT
45	Mays, H. B. (1946)	29	M.	None	Appendix abscess in the pelvis	Absent left kidney, solitary right pelvic kidney with normal function. Absent half of trigone	—	—
46	Schreiber and Smith (1946)	–	F.	Absent vagina and uterus	—	—	—	—
47	Goodhope (1946)	57	M.	None	Benign prostatic hypertrophy	I.V.P.—Solitary pelvic kidney. Absent right half of trigone	Rupture of bladder neck with sound	Died
48	Varnek (1946)	28	F.	Absent left adnexa of uterus	Torsion of ovarian cyst	Absent left half of trigone. Solitary pelvic kidney. Ureteric calculus and hydro-ureter	Laparotomy. Uretero-lithotomy	—
49	Brady (1948)	–	F.	Absent vagina and uterus	Solitary pelvic kidney	—	Laparotomy. Creation of new vagina by Wharton's technique	Satisfactory
50	Nalle, Cromwell, Lynch (1949)	35	F.	Absent vagina	Solitary pelvic kidney	Solitary pelvic kidney. Good function	None	—
51	Berg and Kearns (1949)	39	M.	—	Orthostatic albuminuria	Absent left half of trigone. Functioning solitary right pelvic kidney	—	—
52	Hanbury, W. J. (1949)	50	M.	—	Autopsy, Staphylococcal septicæmia	Central single kidney in the pelvis. Ureter to the left side of bladder	—	—
53	Butler (1950)	24	M.	Incomplete rotation of gut—failure of 3rd part	Peritonitis. Pelvic mass of unknown nature	Absent left half of trigone. Solitary right pelvic kidney. Slight hydro-nephrosis. Short ureter	Laparotomy for gangrenous appendicitis and peritonitis	Satisfactory

of the kidney (Forbes, 1945). The ectopic kidney is situated on the right side of the pelvis twice as often as it is on the left. Usually retroperitoneal and devoid of perirenal fat, the pelvic kidney may lie in the mesosigmoid, in the broad ligament (Herman, 1938), or have a mesentery of its own, again predisposing to torsion (Ransohoff, 1920).

Embryology.—Whilst the general concept of renal development is widely accepted, the cause of failure of the kidney to ascend is disputed. The following hypotheses have been made in the literature :—

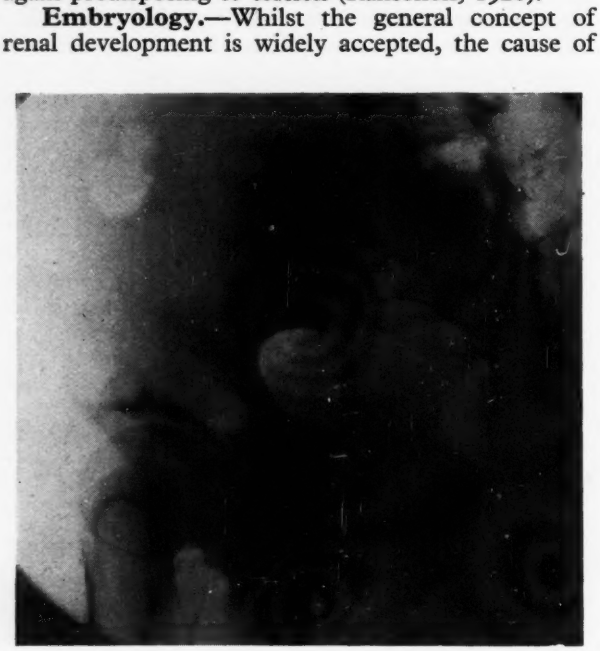

FIG. 732.—Pyelogram of a solitary ectopic kidney—oblique view showing the renal pelvis lying in front of the right sacro-iliac joint.

1. Ransohoff (1920) suggested that arrest was due to the presence of abnormal vessels. It is generally believed, however, that the vessels persist owing to the ectopia rather than the reverse.

2. Lemberger (quoted by Lucas, 1934) considered that the ureters failed to elongate after a certain stage, but Brown (1931) maintained that if the ureters failed to elongate then there was complete cessation of growth of the kidney.

3. Lucas (1934) postulated that excessive enlargement of the Wolffian bodies caused the caudal ends to adhere to the metanephros and pushed the developing kidney towards the midline as a preliminary to fusion. In completely fused pelvic kidney, however, there are always two ureters with separate pelves. In solitary pelvic kidney there is usually only one ureter and pelvis, indicating that one kidney has failed to develop.

4. Carleton (1937) indicated that abnormalities of the origin of the umbilical vessels could obstruct the ascent of the organ.

5. Stevens (1937) believed the condition to be due to unilateral renal agenesis.

6. Gruenwald (1939) considered that the normal change of position of the permanent kidney was due to variations of growth of the surrounding tissue rather than active elongation of the ureter pushing the kidney upwards. He also stated that the normal growth and development of the kidney and ureter was dependent on the ureteric bud gowing out from the Wolffian body at a critical time.

Associated Lesions.—Almost any form of congenital abnormality may be seen in cases of solitary ectopic kidney, but all the female patients in the series presented some genital abnormality. The commonest lesion was absence of the vagina, being present in 17 of 19 patients whose genital defects were fully recorded. In half of these the uterus was absent also. The important fact in these cases is that the ectopic kidney may be mistaken for the uterus. Occasionally there was unilateral absence of a tube and ovary. Guizzetti (1918) stated that genital abnormalities occurred in one-third of all congenital renal defects. Counsellor (1948) investigated 35 patients with absence of the vagina, and 54 per cent of them displayed a congenital lesion of the renal tract, one having a solitary pelvic kidney. The close association of renal and genital abnormalities in the female stresses the fact that the Wolffian and Müllerian systems constitute a single embryological unit. With regard to the male, non-descent of the testes was seen in 2 of 18 patients.

Kidney Function.—When first seen, 25 per cent of the patients had defective renal function, and this proportion increased with time and age.

Clinical Presentation.—Excluding 9 cases recorded at autopsy, the correct diagnosis was made in 18 of the remaining 44 (40 per cent). In less than 25 per cent of cases, however, did the patient present as a urological problem. This point has been stressed by Hanley and Steel (1947). Whilst a palpable swelling and lower abdominal pain were frequent features, others presented with hæmaturia, pyuria, transient albuminuria, tuberculous bacilluria, calculous disease, and paroxysmal hypertension due to torsion of the renal pedicle. Fluctuation in a hydronephrosis of a kidney in the normal position is rarely if ever elicited, but Brain (1943) recorded this physical sign in a patient with a solitary ectopic pelvic kidney. Rarely, difficulty in defæcation, in parturition, and in coitus were noted. About 12 per cent of the female patients presented as 'ovarian cysts', and 4 per cent had a preliminary diagnosis of appendicitis. In the remainder, the diagnosis was established during routine examination or at operation for some other purpose.

The ectopic kidney is more liable to infection, stone formation, and hydronephrosis than is the normal organ, but no more prone to injury or tuberculous disease (Herman, 1938). The occurrence of calculi presents a most difficult problem, and it is widely appreciated that these patients do not tolerate surgical intervention on the urinary tract very well (Lowsley and Mennings, 1944).

CONCLUSION

The problem of solitary ectopic pelvic kidney is of great importance to the urologist, general surgeon, and obstetrician alike, and the wide clinical pattern of its presentation cannot be emphasized too often. The greatest menace is the accidental removal of the pelvic mass before its exact nature is known. Patients with a solitary ectopic kidney carry a considerable risk of early death due to renal failure, and therefore regular review of all such cases is essential.

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DIFFUSE POLYPOSIS OF THE STOMACH

REPORT OF A CASE

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THIS disease is rare. Balfour (1919), working at the Mayo Clinic, found only 1 example of the condition in a series of 8000 gastric operations. Maingot (1948) states that up to 1948 some 175 cases only of this disease had been reported. Brunn and Pearl (1926) collected 84 cases and described an additional 5 cases of their own. Mills (1922), and later Sinclair (1933), described further cases and gave good reviews of the literature.

The polypoid masses may be either neoplastic or inflammatory in origin. Many cases of chronic hypertrophic gastritis give a picture indistinguishable from polyposis of the stomach: the subject is dealt with very fully by Spriggs and Marxer (1943).

The two main pathological forms of polyposis were originally described by Ménétrier (1888). The "polyadenomes polypeux" are discrete globular pedunculated tumours projecting into the lumen of the stomach. They may vary in number from a few to many thousands, and their colour is reddish-brown or grey. "Polyadenomes en nappe" are more solid, flat-topped, projections and are much more localized. The lesion often resembles a carcinoma.

Gastric polyposis is a well-recognized precancerous lesion. Stewart (1929) found that 28 per cent of polypi of the stomach were associated with carcinoma. Miller, Eliason, and Wright (1930) found carcinomatous changes in 8 out of 23 cases—an incidence of 35 per cent. Benedict and Allen (1934) found malignant change in 41 per cent of a series of 17 personal cases. Christopher (1937) reported diffuse adenocarcinomatous changes in a case of gastric polyposis. Finney and Friedenwald (1917) reported the finding of a large gastric carcinoma in a stomach showing diffuse polyposis.

Clinically there are no pathognomonic symptoms. The patient is usually elderly, between 60 and 70 years of age. There is often a long history of loss of weight, anorexia, epigastric pain, nausea and vomiting. The vomit tends to show an abnormal amount of mucus. Hæmatemesis is occasionally found, melæna is frequent, and the resulting iron-deficiency anæmia may vary from mild to severe. For some unknown reason, diarrhœa seems to be a common feature. Achlorhydria is present in about 95 per cent of cases.

Radiological examination usually shows a well-marked mottling effect, with numerous irregular indentations in the outline of the stomach. These filling defects are most prominent in the pyloric region.

Treatment is essentially surgical. With a localized lesion, some form of local excision is feasible, but in all cases of diffuse polyposis total gastrectomy should be performed. In a very recent paper Wise (1950) recommends total gastrectomy as the procedure of choice, although he was only able to trace 5 cases in the literature in which this had been carried out.

In the following report a case of diffuse polyposis is described: it was treated by total gastrectomy.

CASE REPORT

HISTORY.—Mr. A. M., a miller aged 52, was first seen in March, 1947, with a history of recurrent severe epigastric pain and vomiting for the past year. The pain was not related to meals and was not relieved by any antacid mixture. The vomit was usually copious and very slimy in consistency. He had never vomited any blood. Barium-meal examination showed a small filling defect on the lesser curvature of the stomach. A neoplasm was thought of, but excluded on the grounds of a normal test-meal curve. He was treated as a case of gastric ulcer, with definite clinical improvement.

He was next seen in February, 1949, with a recurrence of his symptoms. A repeat barium meal was reported on as follows: "There is a large filling defect of a rather circular nature at the lower aspect of the pars media. This is a constant feature throughout the examination and on relief pictures the mucosal pattern ended abruptly. The appearances are those of an intrinsic lesion of a

polypoid nature in the lumen of the stomach. The chronic course of the disease since 1947 is in favour of this being a simple lesion." The test-meal again showed a perfectly normal curve and no evidence of achlorhydria. In view of the persistence of the man's symptoms, laparotomy was decided upon. At operation, the stomach was grossly enlarged. Gastrotomy was performed, but no definite polypus could be seen. The stomach was found to contain large masses of hypertrophied mucous

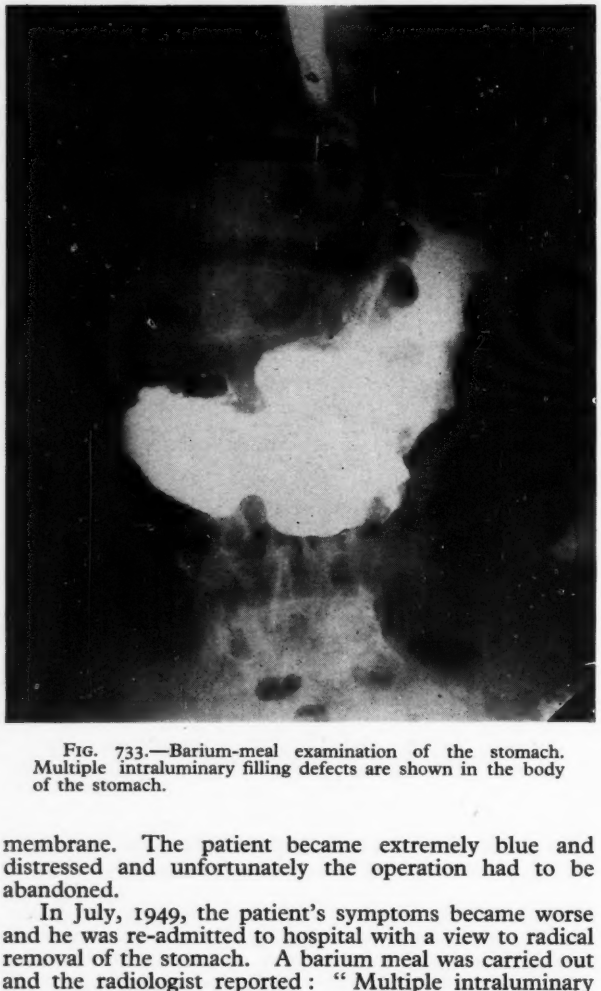

FIG. 733.—Barium-meal examination of the stomach. Multiple intraluminary filling defects are shown in the body of the stomach.

membrane. The patient became extremely blue and distressed and unfortunately the operation had to be abandoned.

In July, 1949, the patient's symptoms became worse and he was re-admitted to hospital with a view to radical removal of the stomach. A barium meal was carried out and the radiologist reported: "Multiple intraluminary filling defects are shown in the body of the stomach, the appearance being compatible with a polypoid condition of the gastric mucosa." (*Fig.* 733.)

AT OPERATION (Aug. 16).—Midline upper abdominal incision. An enormously enlarged stomach was found. On palpation it was obviously thickened and felt just like a 'bag of worms'. The lesion clinically involved the whole of the stomach. A total gastrectomy was performed along with an antecolic œsophagojejunostomy. The afferent and efferent loops of jejunum were joined by a lateral anastomosis.

PATHOLOGY OF THE SPECIMEN.—

Macroscopical Appearance: The stomach was grossly enlarged. The mucosa was markedly convoluted and hypertrophied. Reddish-brown slimy pedunculated tumours, typical of the polyadenomes polypeux described by Ménétrier, extended over the whole of the stomach mucosa. There was no evidence of any surface ulceration or malignant change. (*Fig.* 734.)

Microscopical Appearance (Dr. H. V. Phelon): "The stomach shows well-marked polyposis. Microscopically the lesions appear benign."

POST-OPERATIVE COURSE.—This was complicated by gross abdominal distension and vomiting. At first this was thought to be a paralytic ileus: but when there was no response to conservative treatment and the man's condition was rapidly deteriorating, a quick laparotomy was performed. There was gross dilatation of the whole of the small gut, but no sign of any organic obstruction, or of leakage at the site of anastomosis. He died on Sept. 1, 1949.

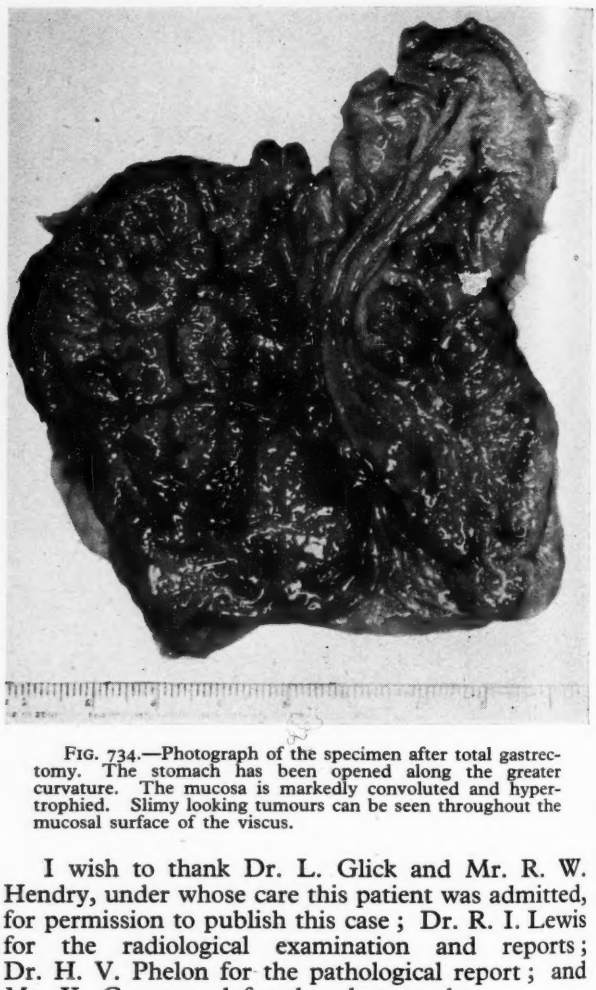

FIG. 734.—Photograph of the specimen after total gastrectomy. The stomach has been opened along the greater curvature. The mucosa is markedly convoluted and hypertrophied. Slimy looking tumours can be seen throughout the mucosal surface of the viscus.

I wish to thank Dr. L. Glick and Mr. R. W. Hendry, under whose care this patient was admitted, for permission to publish this case; Dr. R. I. Lewis for the radiological examination and reports; Dr. H. V. Phelon for the pathological report; and Mr. K. Greenwood for the photographs.

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EXCISION OF THE PUBIC BONE FOR CHONDROSARCOMA

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Chondrosarcoma of the pelvis is an infrequent tumour which generally requires for its proper treatment an interinnomino-abdominal (hindquarter) amputation as described by Gordon-Taylor (Gordon-Taylor and Wiles, 1935; Gordon-Taylor, 1940; Gordon-Taylor and Patey, 1946). When the bone of the acetabulum is not itself involved it is possible that the hip-joint may be spared and the patient retain the use of the limb.

CASE REPORT

History.—The patient, a lady of 53, had experienced two difficult deliveries 22 and 24 years ago and had been told that her pelvis was "narrow". Three years ago she consulted a gynæcologist for pain in the left groin, but was told there was nothing abnormal. Five weeks before admission to hospital (June 28, 1950) she was mowing the lawn when she felt a sudden pain in the left groin and a radiograph a few days later showed a large chondroma or chondrosarcoma arising from the body of the left pubic bone with a pathological fracture at this point (*Fig.* 735). Clinically a hard mass could be felt in the left Scarpa's triangle and above the pubic symphysis, while pelvic examination showed gross displacement of the vagina and rectum backwards and to the right. A radiograph of the chest showed no abnormality. Since the radiographs showed the body of the pubes to be the site of origin and the bone of the acetabular region uninvolved, it was decided to excise the left pubic bone with the tumour.

At Operation.—The patient was placed supine on the operating table with the left buttock and left lower limb almost overhanging the edge, and a slight Trendelenburg tilt. A curved incision was made from just above the right pubic spine to the left anterior superior iliac spine, parallel and 1 in. above the left Poupart's ligament. (*Fig.* 736.) The left rectus abdominis was divided, the left abdominal muscles incised in the line of the incision, and the deep epigastric vessels divided. The peritoneum in the left iliac fossa was now stripped up till the left internal iliac artery was identified and this was tied in continuity. The peritoneum and the soft tissues of the pelvis were now separated from the intrapelvic part of the tumour, part of which lay above the levator ani origin and part below. Poupart's ligament was now divided over the left femoral vein and the femoral vessels mobilized by division of their obturator communicating branches. The left thigh was now flexed and widely abducted by an assistant and an incision made between the perineum and the left thigh from the first incision to the left ischial tuberosity (*Fig.* 736). The incision was deepened and the pubic symphysis divided. With the left thigh well flexed and abducted the left femoral vessels were retracted laterally, the pectineus muscle divided, a Gigli saw passed from within through the left obturator foramen and pulled up on the outer side. Making the saw cut as obliquely outwards as possible the bone was divided close to the acetabulum (*Fig.* 737). The inferior ramus of the ischium was now cleared as close to the tuberosity as possible and a Gigli saw passed around it through the obturator foramen and the bone divided. It was now necessary to divide all the adductor muscles below the tumour in the thigh, the anterior origin of the left levator ani muscle in the pelvis,

Fig. 735.—Radiograph showing cartilaginous and partly calcified tumour of left pubic bone.

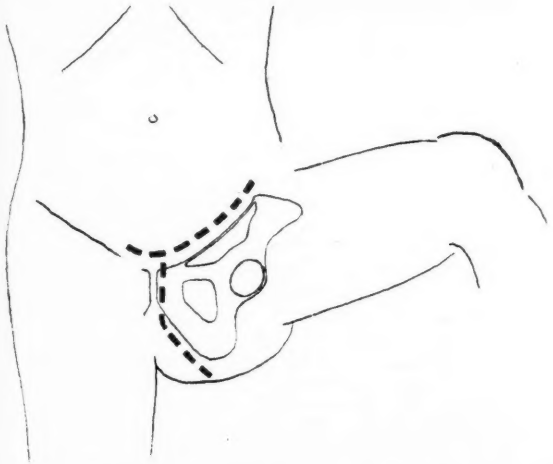

Fig. 736.—Diagram showing line of incision.

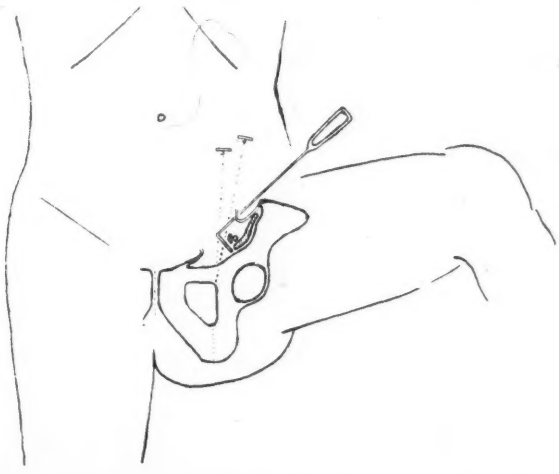

Fig. 737.—Retraction of femoral vessels and division of bone.

the greater part of the origin of the obturator internus and externus, and the triangular ligament and perineal muscles where they were attached to the left ischiopubic ramus. The obturator vessels and nerve were divided in the pelvis. The pubes and the tumour were now free and removed.

The removal left a large gap between the adductor compartment of the left thigh, the retroperitoneal tissues

FIG. 738.—Chondrosarcoma of pubes, showing divided bone near acetabulum (above) and ischial tuberosity (below). (× ⅔.)

of the pelvis, and the left ischiorectal fossa. The left levator and muscle could be sutured in part to the conjoint tendon and this helped to shut off the pelvis from the thigh. The wound was closed with drainage in its dependent part.

Although the patient was transfused during the operation, ligation of the left internal iliac artery prevented any serious hæmorrhage and the only troublesome oozing was

FIG. 740.—Post-operative radiograph.

from the cut tissues near the labia. Her convalescence was uneventful.

The tumour consisted mainly of hyaline cartilage with areas of calcification. Its origin was the body of the left pubis, and the rami, though overshadowed by the intra- and extra-pelvic masses of the tumour, appeared quite uninvolved by growth (*Fig.* 738). Histology showed it to be an osteogenic sarcoma. Its appearance and history suggest the possibility of a malignant change in an old-standing chondroma.

POST-OPERATIVE COURSE.—Although the patient had lost all the adductors of the left thigh she was able to walk the length of the ward unaided five weeks after the operation (*Fig.* 739). Three months after the operation

FIG. 739.—Patient standing on left leg after excision of left pubic bone. (Five weeks after operation.)

her walk appeared normal, though she stated that she had to be "careful on a slippy floor or in the bath". It was feared that she might develop left sacro-iliac strain and perhaps a large hernia into the adductor compartment of the left thigh. This has not occurred, though, in consultation with Mr. H. L. C. Wood, a supporting belt and left inguino-perineal pad has been provided. Radiographs following the operation reveal the gap in the bony pelvis and also some small opaque shadows (*Fig.* 740). These may be phleboliths, small particles from the division of the bone, or possibly small fragments of tumour adherent to the soft tissues of the pelvis when they were stripped away. For this reason the patient has been given a course of deep X-ray therapy by Professor Windeyer. Local recurrence has occurred after hind-quarter amputation for chondrosarcoma.

Comment.—The prognosis after any operation for sarcoma of the pelvis must necessarily be uncertain. If the acetabulum is not itself involved, it may be possible to conserve the hip-joint and, I believe, without affecting the future prognosis. This case shows that the defect in the pelvis following complete removal of the pubic bone and the complete loss of the adductors need cause no great disability.

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ACHOLURIC JAUNDICE AND APPENDICITIS

By T. A. OGILVIE

SURGEON, ESSEX COUNTY HOSPITAL, COLCHESTER

ACHOLURIC jaundice is a somewhat uncommon condition and the clinical course is frequently complicated by the formation of pigment stones in the biliary tract. It is extremely rare, however, for convalescence after splenectomy to be interrupted by an attack of acute appendicitis and for the appendicitis to be caused by the gall-stones.

CASE REPORT

J. H., male aged 21 years, attended the Out-patient Department of the Essex County Hospital, Colchester, in August, 1949, complaining of intermittent slight jaundice for two and a half years. During this period he had had twelve or more attacks, and although the jaundice varied in severity it was never associated with pain. During these attacks he noticed that the urine was dark in colour, but no change in the colour of the fæces was observed. He complained of indigestion and felt blown out, but his appetite remained good and he did not vomit. There was no itching of the skin. The patient has one sister and two brothers, but there was no family history of jaundice.

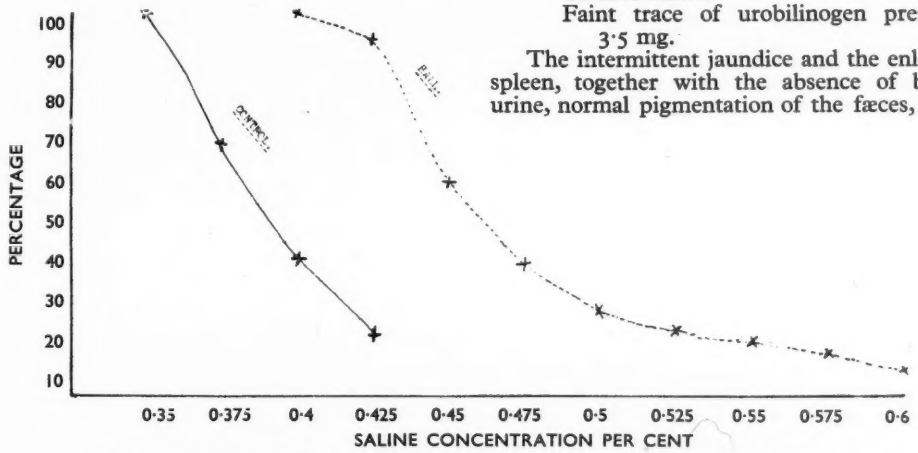

FIG. 741.—Red-cell fragility. Percentage hæmolysis in varying dilutions of saline.

ON EXAMINATION.—The patient was slightly jaundiced and appeared somewhat anæmic. The spleen extended below the left costal margin and was easily palpable. The liver was not enlarged and no free fluid was present in the peritoneal cavity. There was no lymphadenopathy. The following investigations were carried out :—

Blood :—

Total erythrocytes 4,500,000 per c.mm.
Hæmoglobin 98 per cent.
Colour index 1·08.
Total Leucocytes 7200 per c.mm.

Neutrophils	61	per cent.
Eosinophils	1	
Lymphocytes	36	
Monocytes	2	

Packed cell volume 39.
Mean corpuscular volume 86 c.microns.
Mean corpuscular hæmoglobin concentration 37.
Slight anisocytosis and poikilocytosis.
Many of the cells are spherocytes.
Many red blood-cells show polychromasia.
Reticulocytes 11 per cent.
Van den Bergh :—
Qualitative : Delayed direct reaction.
Quantitative : 5 mg. bilirubin per 100 c.c. plasma.
Red-cell fragility :—
Hæmolysis began at 0.6 per cent and ended at 0·4 per cent (*Fig.* 741).
Wassermann and Kahn reactions negative.
Direct Coomb's test is negative.
Group—O. Rh positive.

Urine :—

Lemon clear.
Reaction acid.
Albumin nil.
Fehling's nil.
Deposit nil.
Culture sterile.
Faint trace of urobilinogen present, less than 3·5 mg.

The intermittent jaundice and the enlargement of the spleen, together with the absence of bile-salts in the urine, normal pigmentation of the fæces, the presence of spherocytes, abnormal fragility of the red blood-cells, and excess of reticulocytes, made the diagnosis of acholuric jaundice reasonably certain.

AT OPERATION.—A laparotomy was, therefore, performed through an upper left paramedian incision on Nov. 22, and the spleen, about twice the normal size, was excised without difficulty. The gall-bladder and bile-ducts were palpated but no stones could be felt.

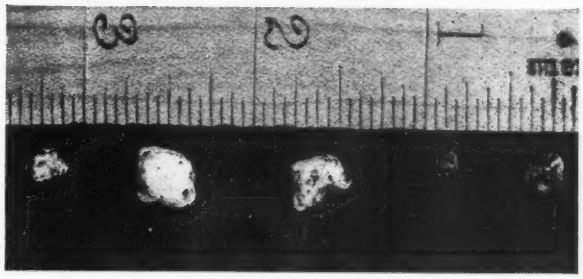

FIG. 742.—Photograph of the stones removed from the appendix.

Following operation the patient made a satisfactory progress until Nov. 25, when he complained of severe pain in the right iliac fossa which was associated with localized tenderness and muscular guarding. Mr. V. G.

Walker, F.R.C.S., the Resident Surgical Officer, made a diagnosis of acute appendicitis and the abdomen was opened through a muscle-splitting incision in the right iliac fossa. Free fluid was present in the peritoneal cavity and a green gangrenous appendix lying against the terminal ileum was removed. During the operation concretions were felt in the cæcum and at the base of the appendix, and it was seen that these concretions were indeed pigmented gall-stones which had caused an acute appendicular obstruction with gangrene and perforation. The photograph (*Fig.* 742) shows the size and number of the stones present in the appendix. Following appendicectomy the patient's progress was uninterrupted, and he was discharged from hospital on Dec. 15.

The Pathologist reported on the spleen and stones as follows :—

Spleen: Capsule and trabeculæ not thickened. Sinuses prominent, but empty. Malpighian bodies normal. No definite abnormality.

Stones: composed of cholesterol, phosphates, and bile-pigments.

There is little doubt that these pigment stones were present in the common bile-duct without giving rise to biliary colic or obstructive jaundice. During the induction of anæsthesia for removal of the spleen the stones passed through the ampulla of Vater into the duodenum, and three days later lodged in the appendix, giving rise to an obstructive appendicitis.

Appendicitis occurring within a few days of laparotomy is notoriously difficult to diagnose and I am much indebted to Mr. Walker for his prompt diagnosis and intervention.

TWO CASES OF TWISTED PYOSALPINX

By JOHN LL. TEMPLE, St. George's Hospital, London

Torsion of a pyosalpinx is a rare accident although a considerable number of cases of twisted hydrosalpinx and hæmatosalpinx have now been recorded. Cathelin (1901) reviewed 41 cases of torsion of the Fallopian tube, and in 4 of these the tube contained pus. Anspach (1912) brought the number of reported cases of twisted pyosalpinx up to 12 and added 1 case of his own, but did not include Targett's (1904) 2 cases. Since then single cases have been

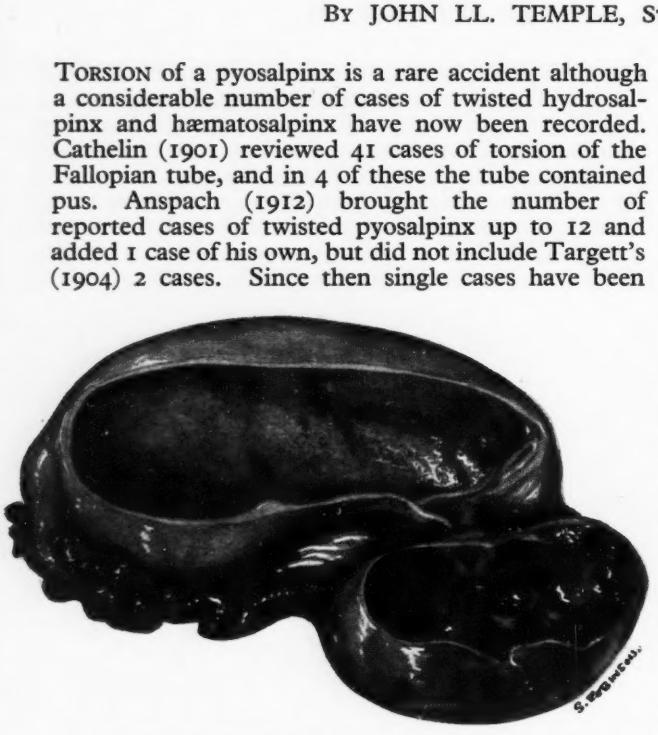

Fig. 743.—*Case* 1. The operation specimen showing pyosalpinx and ovary, cut to show the interior.

recorded by Nash (1922), Weiss and Mathieu (1922), Hamant (1924), Le Balle (1929), and Lapeyre and Fayot (1933), increasing the total to 20. The following 2 case records are therefore of interest.

CASE REPORTS

Case 1.—

History.—An unmarried girl, aged 18 years, was admitted to the West Middlesex Hospital on Jan. 21, 1950, under the care of Mr. John Scholefield. She complained of severe abdominal pain which had started at 3.30 p.m. the same day. The onset was sudden and the pain, situated low in the left iliac fossa, was described as constant but worse on movement. There was no radiation and no pain in the back. Her bowels, usually regular, had opened normally that morning and there were no micturition symptoms. She had vomited about fifteen minutes after the onset of the pain and several times since. Her last menstrual period was normal and had finished three weeks before, but she had some yellowish vaginal discharge.

Past History.—There was a previous history of abdominal tuberculosis, confirmed eighteen months before by laparotomy at another hospital. Three months before admission she had a similar attack of pain which lasted three hours.

On Examination.—The girl was well covered and slightly flushed. Temperature 99·2°, pulse 104. Tongue clean. Heart and lungs normal. The abdomen was tender in both iliac fossæ, more marked on the left side. No renal tenderness. Rectal examination showed tenderness on the left side of the pelvis and movement of the cervix was painful, but no mass was felt.

Diagnosis.—A provisional diagnosis of salpingitis was made and the patient kept under observation. Next morning the pain was worse and the patient had vomited several times in the night. A tender mass could now be felt per rectum on the left side and the diagnosis was changed to torsion of an ovarian cyst.

At Operation.—On Jan. 22 the abdomen was opened through a right lower paramedian incision. There was some blood-stained free fluid in the peritoneal cavity. The small intestine was thickened and pale, with some surface tubercles in the terminal part, but the coils were not adherent to each other. The right ovary was normal, but the right tube was thickened and inflamed. A left pyosalpinx, about 10 × 5 cm. in size, had undergone torsion, together with the left ovary, which was bluish-black in colour and enlarged to twice its normal size. Left salpingectomy and oöphorectomy were carried out and the abdomen closed without drainage.

Post-operative Course.—Convalescence was uneventful. Chest X-ray examination on Jan. 31 showed no abnormality and the patient was discharged on Feb. 4.

Pathology.—The specimen (*Fig.* 743) consisted of the left Fallopian tube and ovary. The tube was distended, with a smooth surface and thickened wall, and contained pus. The ovary was swollen and congested with dark blood.

Histologically the Fallopian tube showed fibrous thickening of its wall, with tuberculous giant-cell systems and a lining of caseous material. The ovary showed diffuse extravasation of blood.

Microscopical examination of the pus revealed no tubercle bacilli, but these were isolated after culture on Lowenstein's medium.

Search in the hospital records as far back as 1937 revealed one other similar case, brief details of which are as follows :—

Case 2.—

HISTORY.—A childless married woman, aged 39 years, was admitted to the West Middlesex Hospital on May 22, 1939, under the care of Mr. D. M. Stern. She complained of colicky lower abdominal pain which had been present for four days and she had vomited on the day of admission. There were no bowel or micturition symptoms. Her periods tended to be irregular, the last having ended seven days before the onset of the pain. The patient had experienced similar pain several times in the past five years.

ON EXAMINATION.—Temperature 99·8°, pulse 104. Tongue furred. Heart and lungs normal. The abdomen moved on respiration and there was tenderness and guarding in the left iliac fossa. A tender swelling was felt in the pouch of Douglas per vaginam.

AT OPERATION (Mr. Stern).—Torsion of a right pyosalpinx was found and salpingectomy performed. The patient made an uninterrupted recovery.

There was no record of the histological findings.

COMMENT

At a meeting of the Obstetrical Society of London in 1904, during a discussion on " Torsion of the Pedicle of Hydrosalpinx and other Morbid Conditions of the Fallopian Tube ", Mr. J. B. Sutton, better known later as Sir John Bland-Sutton, said " it is a fact that the Fallopian tube, when distended with simple fluid, pus, blood, or even when gravid, does twist its pedicle ". Since then torsion of a normal or diseased tube has been reported on many occasions, but twisted pyosalpinx is rare.

The reason for this rarity is not far to seek. Novak (1947) states that pyosalpinx is always bound down by dense adhesions, and Eden and Lockyer (1935), while admitting that hydrosalpinx may occasionally undergo axial rotation, do not include torsion of a pyosalpinx amongst the complications of this condition.

Jameson (1935) describes a tuberculous cold abscess of the tube, well known in the French literature, which occurs when the virulence of the infecting organism is slight or the resistance of the patient is high. This condition, the least common form of tubal tuberculosis, is free from adhesions and may therefore undergo torsion. It is well recognized that it is difficult to distinguish between pyosalpinx due to tuberculosis and that due to other organisms. The pus in both is usually sterile when cultured on ordinary media, and the histological finding of giant-cell systems is necessary for a diagnosis of tuberculosis. Pathological details in the early recorded cases are scanty, and in Anspach's 13 cases evidence of tuberculosis was found in only 2. Of the other 7 cases above mentioned, however, 5 were infected by tubercle bacilli, and it is interesting to note that Targett (1904) considered that practically all cases of twisted pyosalpinx were tuberculous.

The signs and symptoms of this condition are those of a twisted ovarian cyst, though they tend to be less severe, and a correct pre-operative diagnosis is unlikely, even when there is a past history of tuberculous infection.

I am indebted to Mr. Scholefield and Mr. Stern for permission to publish these cases ; to Dr. A. C. Counsell for the pathological report ; and to Miss Robinson for the illustration.

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REVIEWS AND NOTICES OF BOOKS

A Synopsis of Anæsthesia. By J. ALFRED LEE, M.R.C.S., L.R.C.P., M.M.S.A., D.A., Consultant Anæsthetist to General Hospital, Southend ; etc. Second edition. $4\frac{3}{4} \times 7\frac{1}{4}$ in. Pp. 354 + viii, with 66 illustrations. 1950. Bristol : John Wright & Sons Ltd. 15s.

THREE years have passed since the first edition of this valuable Synopsis was published. Although we refer to this book as a synopsis, in point of fact it is rather more, because it does contain much more information than is commonly included in books of this type. The second edition is considerably enlarged and some excellent new material is described. Such fresh information particularly deals with modern innovations such as intravenous procaine, stellate ganglion block, thoracic sympathetic block, and electrical anæsthesia. Another welcome addition is a most valuable account of the causation and treatment of symptoms due to intra-arterial injection of thiopentone. There is also a valuable account of anæsthesia in surgery of the heart and the use of trilene in obstetrics.

We recommend this text-book to all candidates who are studying for Part II of the Diploma in Anæsthetics and to all post-graduates who wish to revise their knowledge of anæsthesia.

The publishers are to be congratulated upon the excellent production of this manual ; the printing is clear, chapters are well arranged, and the sixty-six illustrations are well produced.

In conclusion, we would express the pious hope that further editions of this manual will not be greatly enlarged because to do so, we feel, would trespass on the function of a text-book. However, if it is decided to enlarge it further, let it be as a text-book, in which case we feel sure it would have a very great value.

Surgery of the Shoulder. By A. F. De Palma, M.D., James Edwards Professor of Orthopædic Surgery and Head of the Department, Jefferson Medical College, Philadelphia; etc. 7 × 10 in. Pp. 438 + xx, with 357 illustrations. 1950. Philadelphia and London: J. B. Lippincott Co. £7.

This is a large volume devoted to the anatomy, pathology, and surgery of the shoulder-joint. Commencing with a detailed description of the origin and comparative anatomy of the pectoral limb, the author then considers the normal anatomy and function mechanism of the shoulder-joint. The degenerative lesions of the joint are discussed in detail and ruptures of the musculocutaneous cuff are described. Various fractures and dislocations are described and the various bone tumours of the shoulder-joint considered in full.

The many surgical techniques applied to the shoulder-joint are well described and illustrated.

The book is well printed and profusely illustrated, but the price is prohibitive to anyone except the very rich and one cannot imagine that many practitioners, for whom the book was written, will be induced to purchase it.

Regional Orthopedic Surgery. By Paul C. Colonna, M.D., Professor of Orthopedic Surgery, University of Pennsylvania Medical School. 6⅜ × 9⅝ in. Pp. 706, with 471 illustrations. 1950. Philadelphia and London: W. B. Saunders Co. 57s. 6d.

This book on orthopædic surgery is somewhat different to most in that the author uses a regional approach. This method of presentation should appeal to students and practitioners for it makes for easy reference.

After discussing the physiology of bone and joints the author enlarges on the requisite orthopædic examination and explains his muscle-functioning testing charts. This is an excellent chapter full of practical points which prove of real value to the practitioner.

A consideration of the general pathology of bones and joints is then given and the various bone inflammations, diseases, and growths are explained at length.

The various joints are then considered separately and in detail, together with the results from trauma, infection, and various pathological processes.

A useful chapter on Physical Medicine as applied to orthopædic surgery is given at the end of the book.

Orthopædic surgery to-day is a large subject and its many problems require the correlation of the clinician, radiologist, pathologist, biochemist, and the physical therapist. We are glad to note that Professor Colonna places the most important part of the diagnosis of orthopædic conditions on the clinical examination. The other aids should be brought in to help in the confirmation of the diagnosis.

A very useful and practical book.

Thoracic Surgery. By Richard H. Sweet, M.D., Associate Clinical Professor of Surgery, Harvard University Medical School. Illustrations by Torge Rodriguez Arroyo, M.D. 6⅜ × 9⅝ in. Pp. 345 + xx, with 155 illustrations. 1950. Philadelphia and London: W. B. Saunders Co. 50s.

Thoracic surgery has become an important branch of surgery, and during the last decade has made great advances. The second world war stimulated extensive researches into the problems of traumatic surgery of the chest, and the attack on congenital heart lesions has excited the interest of many of the younger generation of surgeons.

Professor Sweet has written a very practical book which contains his own clinical experience in operative techniques which he has found most useful in dealing with the surgery of the thorax. The numerous illustrations, most of which are original, are from the brush and pen of Dr. J. R. Arroyo, a past master in the art of surgical illustration. Some of the illustrations are the best we have seen in any text-book so far produced. The various drawings give a very real sense of depth, especially in the difficult pictures of the hilum of the lung, and which in the usual flat drawing seen in so many modern text-books is entirely lacking.

Although the author has placed considerable emphasis upon operative technique yet he has not neglected the more medical side of the problem of chest conditions.

An excellent chapter is devoted to the subject of abdominal operations performed through the thorax, while another chapter deals with the surgery of the diaphragm.

The author is to be congratulated on this book and for getting all his material into less than four hundred pages of text.

Fifty Years of Medicine. A Symposium from the *British Medical Journal*. 6 × 9½ in. Pp. 330 + viii. Illustrated. 1950. London: British Medical Association. 15s.

The volume contains the various articles which appeared in the *British Medical Journal* of Jan. 7, 1950. The articles were devoted to a survey of medical progress during the fifty years 1900–49.

Sir Geoffrey Jefferson writes on the growth of surgery and gives an interesting and critical survey of those momentous years, for it must be acknowledged that more progress has been made in the field of surgery in the last fifty years than in any other like period.

Sir Henry Dales gives an excellent account of the advances in medical therapeutics, while Sir Henry Cohen dilates on fifty years of medical research and practice.

Sir Lionel Whitby writes on clinical pathology and Sir Robert Hutchison enlarges on the interesting theme of medicine to-day and yesterday.

Professor Grey Turner, one of the few surgeons who knew surgery as it was in 1900, gives an excellent account of the limitations of the art and practice of surgery at that time. There are some nineteen chapters in this volume, all dealing with some facet of medical progress during the last fifty years.

A very interesting volume, and one which will remain as a reference book for the period 1900–49.

A Surgeon's Fight to Rebuild Men. An Autobiography. By Fred H. Albee, M.D., F.A.C.S., F.I.C.S. 5½ × 8½ in. Pp. 270, with 11 Plates and 14 text illustrations. 1951. London: Robert Hale Ltd. 15s.

This is the autobiography of a famous American orthopædic surgeon who has for many years enjoyed an international reputation. The story of men's lives in an autobiography may be made or marred by the way the story is told no matter how famous the man may be.

Dr. Albee has much to tell of a long and exciting life, and he tells his story admirably. His style is simple, lucid, and intensely interesting. Having discovered the method of bone-grafting, he preached it to the world at large in 1911, and he saw the fruits of his labours during and after the first world war when many thousands of wounded and shattered limbs were saved and made useful again. The various uses of a bone-graft in surgery to-day are legion; bone plastic surgery is universally practised.

Albee tells us the story of his early years as a pioneer, difficult years but progressive, culminating in the position he holds to-day as one of the great surgeons of our time.

He informs us of his struggles, and the introduction of his revolutionary methods in surgery, of his travel and study in foreign countries, his position as head of the great American health services, and his work as a pioneer in the field of human rehabilitation.

The life history of a famous surgeon told in a delightful manner.

Pathology in General Surgery. By PAUL W. SCHAFER, M.D., Professor of Surgery, University of Kansas School of Medicine. 7¼ × 10½ in. Pp. 581 + xvi, with 495 illustrations, 368 in colour. 1950. Chicago, Ill.: University of Chicago Press. (London: Cambridge University Press.) £6 11s. 6d.

THIS is a book which will interest all thoughtful surgeons, for it is written by a surgeon who has had an interesting background of pathology. It is written from the point of view of a clinician and correlates in an able manner the clinical condition with its underlying pathology. Perhaps the main feature of the book is the 368 coloured plates of ample size and reproduced in a beautiful manner. These plates depict the gross and microscopical features of many and varied surgical conditions. Congenital defects, inflammation, and neoplasms are arranged and presented in sequence.

What a book for the undergraduate! The reviewer only wishes he had such help in his student days when books of this calibre were non-existent. But students are not the only people who will benefit by reading this book; it will be found of value to professors of surgery and general pathology. A wonderful production.

Congenital Heart Disease. By J. W. BROWN, M.D. (Lond.), F.R.C.P., Physician to the Grimsby General Hospital; etc. Second edition. 5½ × 8½ in. Pp. 344 + xiv, with 128 illustrations. 1950. London: Staples Press Ltd. 30s.

THE first edition of this book appeared in 1939 and was based on the clinical study of a large number of cases of congenital heart disease observed in schoolchildren over many years and amplified by an excellent review of the literature. It at once placed its author in the front rank as an authority on congenital heart disease. The new edition has been eagerly awaited owing to the greatly increased interest in the subject following on the development of successful surgical treatment.

This new edition merits much praise, for it is still a notable work based on considerable personal clinical experience amplified by clear and concise explanations derived from a study of the literature of many of the rather obscure developmental problems. At the same time it is unfortunately necessary to criticize adversely a number of features, the weakness or inaccuracy of which are doubtless thrown into evidence because of the recent great advances. Whereas the older type of largely clinical approach to these cases is well portrayed, the more modern methods of intensive investigation and assessment are lacking, and the scanty presentation and appraisal of surgical treatment is inadequate in 1950.

Personal statistics are surprisingly absent; statistics must play an important part in this subject and many are quoted from the literature, but why, on page 55, does the author not give an analysis of his own 43 cases of subaortic stenosis instead of making vague generalizations? Again, on page 63, in dealing with coarctation of the aorta, it is difficult to see what is meant by "personal experience suggests it may be more common in the female than statistics indicate". What are his own statistics and how do they misrepresent the results of his own personal experience?

Amongst a fair number of definite errors one notes, pages 105 and 260, the statement that a "bicuspid pulmonary valve is the constant accompaniment of the tetralogy of Fallot". Suzman's sign is said to show the dilated intercostal arteries when the patient bends forwards. On page 131 post-stenotic dilatation of the branches of the pulmonary artery, most often the left, is described as if it were an entity or a primary disease instead of a secondary phenomenon. Very controversial is the suggestion (pages 117 and 125) that patent ductus arteriosus is not often seen after the second decade as it may then close spontaneously.

The gravest omissions are in the extremely scanty and unauthoritative presentation of cardiac catheterization and of angiocardiography, and at times complete omission of any mention of their value or importance; on page 70 no mention is made of aortography in the investigation of aortic coarctation. Surgical treatment, which is to-day the real reason for the great interest in congenital heart disease, is dealt with in scattered short remarks here and there in the book, and in one single page at the end. Most of the remarks are inadequate or incorrect. Thus, the huge literature of the surgery of patent ductus arteriosus is almost ignored. The operative results of aortic coarctation are referred to in 20 cases operated on by Crafoord, who has reported many more than this; other reports on really large series have also been published by Gross and others. In discussing the treatment of pulmonary valvular stenosis (page 182) the Blalock-Taussig operation is advised, whereas it is generally accepted that valvulotomy is the only correct treatment and both Blalock and Taussig have affirmed that their anastomotic operation should not be done on such cases. Incidentally there is no statistical presentation or real assessment of the results of the Blalock procedure.

Although this book contains much information of great value and must be read by all those interested in the study of congenital heart disease and must find a permanent place on their shelves, it cannot retain its former place in the front rank unless it remedies these grave omissions in regard to the application of the newer methods of investigation and a full recognition of the important place that operations have played and are playing in the management of these cases. Congenital heart disease no longer forms a field of pleasant interest or a somewhat unpractical clinical hobby; it is concerned with serious attempts to relieve a serious disability by surgery of a difficult and exacting but none the less successful nature.

Diseases and Treatment of Tumors of the Head and Neck. By GRANT E. WARD, M.D., D.Sc., F.A.C.S., and JAMES W. HENDRICK, M.D., M.S., Maryland. 6⅞ × 10 in. Pp. 832 + xvi, with 9 coloured plates and 637 illustrations. 1950. Baltimore: The Williams & Wilkins Co. (London: Bailliére, Tindall & Cox.) 114s.

THIS large volume has been written by two surgeons who have been associated with tumour clinics for many years and of necessity they have seen and treated many thousands of tumour cases. There can be no doubt that during recent years enormous strides have been made in the development of surgery and, therefore, there has been a real necessity for books dealing with limited portions of the body.

This volume is comprehensive, and the authors have stressed the importance of early diagnosis and the correct form of treatment. The text is well illustrated by over six hundred photographs, drawings, radiographs, and photomicrographs. The coloured plates are excellent and could not be bettered.

The viewpoints of the surgeon and the radiotherapist are discussed and the different forms of treatment are compared.

This book will long remain as a reference volume for the general surgeon, the dental surgeon, and the X-ray therapist, while the general practitioner will find it a mine of information.

The 1950 Year Book of General Surgery. Edited by EVARTS A. GRAHAM, A.B., M.D., Professor of Surgery, Washington University School of Medicine; etc. 5⅛ × 7¾ in. Pp. 670 + xvi, with 193 illustrations. 1950. Chicago: Year Book Publishers Inc. $5.00.

WE have come to recognize the value and usefulness of the *Year Book of General Surgery* because of the excellent

balance that is maintained throughout the volume; only articles of real merit and value are abstracted. Professor Graham has a very happy knack of knowing what to include in the volume out of the enormous mass of international surgical literature.

We are glad to see that the heart and mediastinum and the kidneys are recognized as areas in which the general surgeon may conduct his practice.

As in the former volumes, we have nothing but praise for the production of this really useful book.

Lumbar Puncture and Spinal Analgesia. By R. R. Macintosh, M.A., D.M., F.R.C.S. (Edin.), D.A., Nuffield Professor of Anæsthetics, University of Oxford. 5½ × 8½ in. Pp. 149 + viii, with 111 illustrations. Edinburgh: E. & S. Livingstone Ltd. 21s.

THIS is an important yet small monograph which has appeared at an opportune time, for there are far too many tragedies following spinal anæsthesia to-day. Professor Macintosh has rightly stressed the importance of a knowledge of the anatomy of the lumbar spine and the spinal cord in that area. It is quite common for the spinal cord to descend to the lower border of the third lumbar vertebra, and therefore anyone performing lumbar puncture should remember this fact. The whole subject of lumbar puncture and spinal anæsthesia is discussed and the text is well illustrated with excellent drawings, some of which are in colour.

A very useful chapter at the end of this book is devoted to "Do's, Don'ts, and Doubtfuls", and the student and young anæsthetist will find sound advice here.

Management of Peripheral Arterial Diseases. Being revised and enlarged from *The Diagnosis and Treatment of Diseases of the Peripheral Arteries*. By SAUL S. SAMUELS, A.M., M.D., Chief of the Department of Arterial Diseases, Stuyvesant Polyclinic Hospital, New York; etc. 5½ × 6½ in. Pp. 345 + xviii, with 112 illustrations. 1951. New York: Oxford University Press. 60s.

THIS book is in reality based upon the author's two previous editions of *The Diagnosis and Treatment of Diseases of the Peripheral Arteries*, and is the outcome of Dr. Samuels' extensive experience covering the last twenty-five years, during which many thousands of cases of gangrene passed through his hospital. With this rich experience of clinical cases the author has a background which is second to none. He has written a book in which the fundamental principles of the diagnosis and treatment of all peripheral arterial diseases are put in their proper perspective.

The mature experience of the author has made him take a conservative outlook on the treatment of gangrene, and his advice is sound to a degree.

The book is well illustrated both with clinical photographs and excellent radiographs.

To-day as never before has the importance of peripheral arterial disease been recognized by the profession because of the tendency of the race to live longer and so suffer from some form of vascular disease.

John Hunter. By S. ROODHOUSE GLOYNE, M.D. (Leeds), Consulting Pathologist, London Chest Hospital, and King Edward VII Sanatorium, Midhurst. 6¼ × 8⅝ in. Pp. 104 + x, with Frontispiece and 16 Plates. 1950. Edinburgh: E. & S. Livingstone Ltd. 15s.

ALMOST one would have thought that all that was known of Hunter had already been committed to print, and that there was nothing left to record. The biographies of Stephen Paget and of Peachey, and an uncountable succession of Hunterian Orations have left little for a fresh writer to record. Yet, *il faut prêcher son saint*. To one so imbued with the Hunterian conviction that in the study of pathology will be found the truths on which scientific therapy must be based, the urge to present the portrait of the great Apostle of Surgery was irresistible. Dr. Gloyne's study, though a short one, is a memorable and satisfying portrait of the rough Scot against the London background, working single-handed "from the rising to the setting of the sun" in his passionate determination to seek out the facts of Nature that he might understand them, and understanding, place the surgeon's craft upon an unshakeable pedestal of scientific truth.

This is a wholly delightful presentation of the largely self-taught man, with few social graces, passionately centred on his work, and of his wonderfully patient, self-effacing wife, coping with fantastic domestic difficulties, set against the background of eighteenth-century London with all its gaiety and squalor.

Regrettably, Dr. Gloyne did not live to see his book in print, nor to read the encomiums which his work so richly deserves, but he has left us the richer for a delightful miniature, faultlessly reproduced by his publishers.

British Surgical Practice Index. Under the General Editorship of Sir ERNEST ROCK CARLING, F.R.C.S., F.R.C.P., Consulting Surgeon, Westminster Hospital, and Sir JAMES PATERSON ROSS, K.C.V.O., M.S., F.R.C.S., Surgeon and Director of Surgical Clinical Unit, St. Bartholomew's Hospital; Professor of Surgery, University of London. In 8 volumes (with Index Volume). 6½ × 9⅝ in. Pp. 363 + viii. 1951. London: Butterworth & Co. £1.

THE complete index to the eight volumes of the comprehensive work, *British Surgical Practice*, is a most useful volume, for it will save the reader much time in looking up the actual references. There are, for instance, no less than nine pages devoted to references dealing with carcinoma. Any reader who tries to find out any particular aspect of carcinoma will find it in less than a minute in the index, but it might take him a long time if he had to refer to several large volumes.

As a complete work the eight volumes and the index are a great credit to British Surgery, and Sir Ernest Rock Carling and Sir James Paterson Ross, their associate editors, and the numerous contributors, may well be proud of their work.

In the past other complete works on surgery have emanated from British surgeons, but the present comprehensive production far outshines them all.

Modern Trends in Neurology. Edited by ANTHONY FEILING, B.A., M.D., F.R.C.P., Senior Physician, Neurological Department, St. George's Hospital and Maida Vale Hospital for Nervous Diseases; Consulting Physician, Royal National Orthopædic Hospital, London. 6½ × 9⅝ in. Pp. 717 + ix, with 202 illustrations. 1951. London: Butterworth & Co. 63s.

THIS is a most useful volume not only to the neurosurgeon but also to the general surgeon who may be faced with neurological problems which may occur in his practice.

The book deals with subjects of neurological interest in which there have been recent valuable advances.

The subject of neurosyphilis is dealt with in a masterly manner by Dr. Worster-Drought. Joe Pennybacker writes interestingly on abscess of the brain, a subject he has made his own. It is instructive to note that before the advent of penicillin the mortality-rate of bronchogenic abscess was 100 per cent, while to-day, with penicillin as an adjunct to operation, the mortality-rate is about 33 per cent.

Intracranial tumours and the advances which have been made in their treatment during recent years are

described in a fascinating manner by D. W. C. Northfield and Dorothy Russell and the illustrations in this chapter are superb.

Dr. S. P. Meadows writes on intracranial aneurysms and deals with the modern surgical treatment which may be employed. The use of arteriograms in the diagnosis of various aneurysms is stressed and many beautiful arteriograms illustrate this chapter.

William Jason Mixter deals with the important problem of rupture of the intervertebral disk, and gives good account of his matured clinical observations during the last sixteen years since this condition has been recognized as a clinical entity.

Dr. J. W. D. Bull contributes a valuable chapter on diagnostic radiology, a subject which has made great strides during the last decade.

Throughout the book the illustrations are excellent and greatly enhance the value of the text. A comprehensive bibliography and list of references are given at the end of each chapter.

The wide scope of this work, with its emphasis on new facts and new ideas, will appeal to the research worker as well as to the neurologist, the neurosurgeon, and the senior student of neurology. It will remain a book of reference for many years to come.

Injuries to the Ankle. By J. GRANT BONNIN, M.B., B.S. (Melbourne), F.R.C.S. (Eng.), Orthopædic Surgeon, Central Middlesex Hospital. 5½ × 8¾ in. Pp. 412 + xvi, with 399 illustrations. 1950. London: William Heinemann (Medical Books) Ltd. 63s.

BEGINNING with a historical survey from Ambroise Paré to Arbuthnot Lane, followed by an excellent account of the anatomy of the ankle region, the author passes to a consideration of radiography of the joint region, the mechanism of production of fractures and ligamentous lesions and epiphysial separations, and treatment, both conservative and operative. We are told that of the great joints of the lower limb, the ankle stands first in anatomical peculiarity, second in traumatic importance, and third in the frequency with which it is involved by disease, and that no detailed treatise on injuries of the ankle has hitherto been published in English. The author would fain evoke the spirit of Lane and believes that early effective surgery (open reduction) is the secret of success in many serious injuries of the ankle. The book is a comprehensive account of the subject, made up of a series of chapters headed by more or less appropriate quotations which add interest for the reader and concluding by a brief account of terminology and a glossary of terms used. It is well documented by references and illustrated by coloured and line drawings, photographs, and radiographs, and we congratulate Mr. Bonnin on admirably filling a gap which he points out has previously existed as regards this subject.

Facial Paralysis. Being a Treatise on a Clinical Classification of Paralysis of the Facial Nerve. By J. PARKES FINDLAY, M.B., Ch.M., Honorary Assistant Aural Surgeon, Sydney Hospital. 6 × 9⅝ in. Pp. 48. Illustrated. 1950. Published by Author. (Distributed by Angus & Robertson Ltd.) 17s. 6d.

SIR CHARLES BELL described facial palsy of the lower motor neurone type in 1830, and cases of paresis or paralysis of the nerve have since been called Bell's palsy. The author of this little book reviews the various types of peripheral paralysis of the facial nerve, and classifies them as: (1) geniculate, (2) neuritic, (3) those due to vascular occlusion, and (4) traumatic. Hunt's work on sensory fibres in the nerve as shown by the distribution of vesicles in herpes oticus arising from involvement of the geniculate ganglion is quoted, and methods of examination, symptomatology, and diagnosis are discussed. A virus is held responsible for the geniculate lesion. In neuritic paralysis, pain is absent and focal sepsis is believed to be the cause. Paralysis due to vascular occlusion postulates an interference with the vasa-nervorum and is regarded as due to allergy or endarteritis, and a decompression is advised. For traumatic facial paralysis, surgical treatment is advocated early, e.g., within six weeks. Not all will agree with this, as many cases recover spontaneously after some six months. A brief account of prognosis completes a useful and informative little book in which there is much of interest even though some will not go all the way with the author. Some thirty references are listed. There is no index.

Atlas of Human Anatomy, Descriptive and Regional. By M. W. WOERDEMAN, M.D., F.R.N.A.Sc., Professor of Anatomy and Embryology and Director of Anatomy Department, University of Amsterdam. Volume II, **Splanchnology, Angeiology, Nervous System, Organs of Sense.** 1950. Amsterdam: Wetenschappelijke Uitgeverij N.V. (London: Butterworth & Co. (Publishers) Ltd.) 63s.

THE appearance of Professor Woerdeman's first volume certainly whetted our appetite and now the second volume has appeared we are captivated with the accuracy and excellence of the illustrations. The second volume deals with splanchnology, angeiology, nervous system, and the sense organs.

The illustrations are all original and some of them are unique.

As a work of reference this book could not be bettered and there can be no doubt that it will make its mark as one of the really useful books in medicine, for it will prove of value not only to students but also to anatomists, physiologists, surgeons, and clinicians in every branch of medicine.

Anatomy is certainly not a dead subject when one looks at a book of this calibre with its excellent reproduction of fascinating dissections.

A Text-book of X-ray Diagnosis. By British Authors. In four volumes. Edited by S. COCHRANE SHANKS, M.D., F.R.C.P., F.F.R., Director, X-ray Diagnostic Department, University College Hospital, London, and PETER KERLEY, M.D., F.R.C.P., F.F.R., D.M.R.E., Director, X-ray Department, Westminster Hospital; Radiologist, Royal Chest Hospital, London. Second edition. 6⅝ × 9¼ in. Vol. I. Pp. 434 + xiv, with 439 illustrations. Vol. II. Pp. 702 + xiv, with 605 illustrations. 1951. Volume III, Pp. 830 + xvi, with 694 illustrations. Volume IV, Pp. 592 + xvi, with 553 illustrations. London: H. K. Lewis & Co. Vol. I, 45s.; Vol. II, 65s; Vol. III, 70s.; Vol. IV, 60s.

SOME ten years have elapsed since the first edition of this work appeared, but during that time no fewer than five reprintings have been necessary, and this fact alone demonstrates the real value of the work.

This new edition has been very thoroughly revised, and in Vol. I, which is devoted to the head and neck, there are five parts. Part 1 is devoted to the central nervous system and is contributed by Sir Hugh Cairns and Mr. M. H. Jupe, and gives a very characteristic survey of the diagnostic value of radiographs in the various tumours and conditions in the brain and spinal cord. The radiographs are of good quality and well produced. Part 2 deals with the teeth and jaws and is written by Dr. H. M. Worth, who is well qualified to undertake this subject, and his chapters are profusely illustrated with excellent radiographs which enhance in no small way the value of the written word.

Part 3 concerns the eye, and is contributed by Dr. R. G. Reid, who makes his chapter of real interest by convincing the reader of the importance of X rays not

only in localization of foreign bodies in the eye but by demonstrating the value of dacryocystograms.

Parts 4 and 5 are written by Sir Harold Graham-Hodgson and deal with the accessory nasal sinuses and the ear and temporal bone, subjects which he has for many years made his own peculiar study.

The whole volume is one of condensed knowledge in X-ray diagnosis, and it is the finest work so far produced in the English language.

Volume II is devoted to the cardiovascular and respiratory systems and is edited by Dr. Peter Kerley. The numerous illustrations are of a high standard and give the reader an excellent idea of the various pathological conditions in the chest. To-day as never before the clinician relies more and more on radiographs to help not only in diagnosis but also in prognosis and to see how various forms of treatment affect the lung shadows.

There is a very comprehensive and complete bibliography at the end of this volume which should prove of real value to readers who are interested in special subjects. Much progress has been made in the last decade in the X-ray diagnosis of the various virus pneumonias, and in this volume an excellent account is given of these conditions.

Carcinoma of the lung has become more frequent of late and X rays play an important part in the early diagnosis of this disease. The radiographs illustrating malignant conditions of the lungs are well produced in this volume.

This is an outstanding work and can be confidently recommended to student and practitioner alike.

Volume III contains some 830 pages with nearly as many illustrations; this gives the reader an idea of the size of this book. This volume is devoted to the X-ray diagnosis of the alimentary tract, radiology in obstetrics and the urinary tract.

One of the great features of this work is that the authors give an account of the normal X-ray appearances of the organs concerned before they discuss the abnormal. This is excellent, for it enables comparisons to be made between the normal and pathological. Although the medical student while doing his anatomy and physiology is supposed to be instructed in the normal X-ray appearances of bones, joints, and viscera this is often neglected as the anatomical departments have not all got facilities to demonstrate these normal X-ray pictures. It is, therefore, not until he commences his clinical studies that he realizes that he must compare the normal with the abnormal. This book should prove of real value to all undergraduate and postgraduate students.

We would like to congratulate the authors on the excellence of the skiagrams which for the most part illustrate this volume. X rays play an ever-important role in the diagnosis of fœtal positions in utero and also in giving the shape of the pelvis. The value of X rays in urinary surgery become more important each year and the part of this volume devoted to the urinary tract is excellent and the X-ray pictures could not be bettered.

Volume IV deals for the greater part with diseases of the skeleton. An excellent description is given of the normal X-ray appearances of bones and joints, and this is followed in turn by the general pathology of bone. The various congenital deformities of bones and joints are described in an interesting and lucid way.

The traumatic lesions of the skeleton are described in full and the skiagrams which illustrate this section are particularly good. Inflammatory diseases of bones and joints are discussed at length, while the constitutional diseases and tumours and cysts are fully portrayed and illustrated.

Each section contains an up-to-date bibliography which enhances the value of the book.

The authors may feel proud of the fact that this work is a credit to British Radiologists and is by far the best four-volume production in the English language.

Pre-frontal Leucotomy. A Survey of 300 Cases personally followed over 1½–3 years. By MAURICE PARTRIDGE, M.A., D.M. (Oxon.), D.P.M. (Eng.), Assistant Psychiatrist to St. George's Hospital, London. 5½ × 8½ in. Pp. 496. 1950. Oxford: Blackwell Scientific Publications. 42s.

THIS book is a survey of 300 cases of pre-frontal leucotomy which have been followed by Dr. Partridge over a period of eighteen months to three years. All the cases were operated upon by Mr. McKissock, and therefore there was a certain uniformity of the operation. There are few books of this type in medical literature, for the whole text is devoted to the analysis of the clinical manifestations following operation.

We have read much about the after-results of pre-frontal leucotomy in many and varied medical newspapers, but here we have a comprehensive scientific work on the clinical side.

It gives the reader a clear, concise idea of what may and may not be expected after this operation.

The book is well written and the case histories are full and interesting. These investigations have been compiled more completely, uniformly, and personally than has hitherto been done.

Dr. Partridge has presented the profession with a valuable monograph which will become the reference volume for many years to come.

BOOK NOTICES

Archives of the Middlesex Hospital. Vol. I. No. 1. 6¾ × 9⅝ in. Pp. 77 + iv. Edinburgh: E. & S. Livingstone Ltd. Annual subscription, £2 2s. Single number, 12s. 6d.

Pedicle Flaps in Plastic Surgery of the Head and Neck. By GORDON B. NEW, M.D., F.A.C.S., Professor of Plastic Surgery, and JOHN D. ERICH, M.D., F.A.C.S., Associate Professor of Plastic Surgery, Graduate School, University of Minnesota, Minneapolis. 6 × 9 in. Pp. 104 + vii, with 76 illustrations. Springfield, Ill.: Charles C. Thomas. (Oxford: Blackwell Scientific Publications Ltd.) 21s. 6d.

Indications for and Results of Splenectomy. By FREDERICK A. COLLER, M.D., ALEXANDER BLAIN, III., M.D., and GOULD ANDREWS, M.D., from the Departments of Surgery and Medicine, University of Michigan Medical School, Ann Arbor, Michigan. 5½ × 8½ in. Pp. 100 + viii, with 16 illustrations. 1951. Springfield, Ill.: Charles C. Thomas. (Oxford: Blackwell Scientific Publications.) 16s. 6d.

The Student's Handbook of Surgical Operations. By Sir FREDERICK TREVES, Bart. Ninth edition, revised by Sir CECIL WAKELEY, K.B.E., C.B., D.Sc., P.R.C.S., Senior Surgeon to King's College Hospital; etc. 4⅝ × 7¼ in. Pp. 580 + xii, with 269 illustrations. 1951. London: Cassell & Co. Ltd. 15s.

The 1950 Year Book of Urology. Edited by WILLIAM WALLACE SCOTT, M.D., Ph.D., Director, James Buchanan Brady Urological Institute; The Johns Hopkins Hospital; Urologist in Charge, The Johns Hopkins Hospital; Professor of Urology, The Johns Hopkins University School of Medicine. 5 × 7¾ in. Pp. 416, with 87 illustrations. Chicago, Ill.: Year Book Publishers Inc. $5.00.

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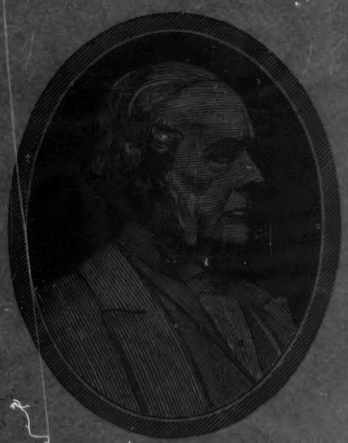

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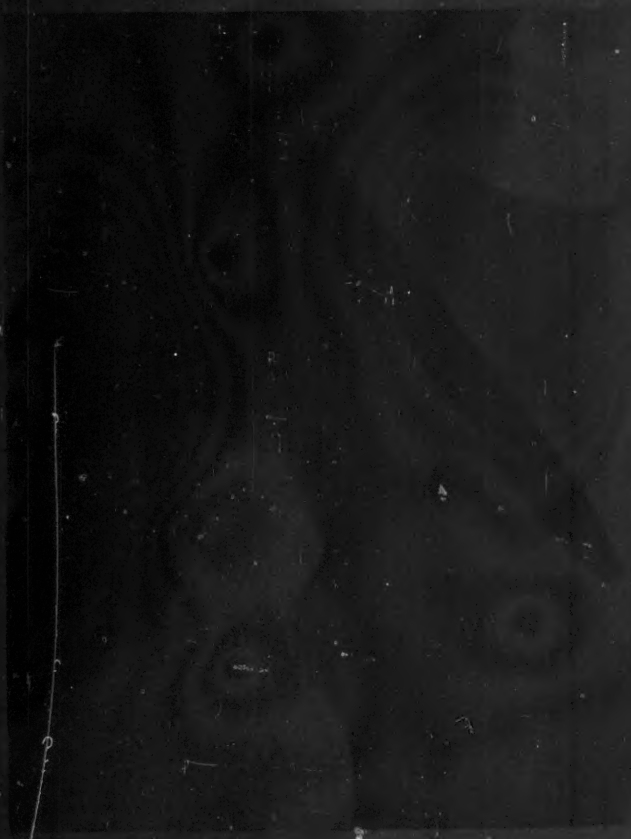

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